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ABSTRACT

Project CAPABLE (Classroom Action Program: Aim: Basic Learning Efficiency) is a classroom approach which integrates the basic learning skills with content. The goal of the project is to use basic learning skills to enhance the learning of content and at the same time use the content to teach basic learning skills. These monthly reports explain how the basic learning skills can be taught in general science and biology classes. One learning skill is covered by each monthly report. They include: Learning Skills; Comprehension Development; Vocabulary Development; Directed Reading Activity (DRA) and SQ3R (Survey, Question, Read, Recite, Review); Study Skills; Management Techniques; Structured Overviews and Study Guides; and Interest, Motivation, Assessment. (BS)

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SCIENCE

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Project CAPABLE

CLASSROOM ACTION PROGRAM:

AIM: BASIC LEARNING EFFICIENCY

"to make each student a more capable learner"

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AUGUST REPORT

LEARNING SKILLS

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TM 840 720

TITLE IV: PART C
DEVELOPMENTAL GRANT

SCIENCE

Paul Germann

The purpose of Project Capable is "to make each student a more capable learner." We propose to achieve this by being aware of the basic learning skills possessed by each learner. The learner must have the basic skills required to learn content. If these skills are inadequate his learning will be ineffective. The job of the classroom teacher is to use the basic learning skills the student already knows to help him learn content and to use the content to increase the student's proficiency in learning skills.

To begin this task, the basic learning skills needed to learn science must be identified. Once this is done attention can be focused on determining how proficient each student is in each skill and provide exercises suited to that student.

Learning occurs through the senses. We learn about the world around us by seeing, hearing, touching, smelling and tasting. To learn we must receive this information from our environment and assimilate it into our general fund of knowledge.

In the classroom the student uses his senses of seeing and hearing to the longest extent. He must take the ideas he has observed, read and/or heard, understand them, assimilate them and then be able to communicate through speaking, writing and/or demonstration what he has learned. This requires proficiency in three general areas of basic learning skills:

(1) General Language Arts Skills
(2) General Study Skills
(3) Special Skills in Science

Language Arts Skills - Language Arts Skills can be considered in 2 areas: I. Wor Recognition & II. Comprehension

I. Word Recognition: Students must be able to recognize words they read, hear, and use and associate with those words the appropriate meaning. This requires certain subskills.

A. Left to right eye movement (5)

B. Auditory perception (1)

C. Picture - Object clues (symbols) (1)

D. Word form clues (printed and cursive) (1)

E. Phonetics in Pronouncing New Words (9)

F. Word Structure Techniques (9): determine meaning from base words, prefixes and suffixes, compound words, accents and syllables.

G. Understand how new words enter our language and our coined. (2)

H. Context clues (9)

I. Word Helps (9) such as pronunciation guides

J. Associating accurate meanings to words in context

K. Words that represent concepts or schemes

II. Comprehension: Comprehension of what is seen, read or heard can occur at three levels:

A. Literal B. Interpretive C. Critical

A. Literal: (9) The learner understands the direct literal meaning of what is seen, read or heard in light of the purpose set. The observer understands only the actions and activities he sees. He does not understand why or for what reason. The reader or listener understands only what is "spelled out." He does not make inferences, see relationships, draw conclusions or predict. He cannot judge accuracy or relevancy. Several subskills enter into literal comprehension.

1. Selecting main ideas
2. Selecting significant supporting detail
3. Eleminating irrelevant details
4. Following directions (11) (2)

5. Following sequence (2)
6. Classify convergently
7. Recording observed information in outline, graph, map etc.
8. Reading outlines, graphs, maps and charts

B. Interpretation: The learner thinks beyond the literal to understand in greater depth. He puts together ideas that are not related overtly in what he sees reads or hears.

1. Comparison and contrast
2. Implication: inferences, relationships, connections
3. Cause and effect: predict outcomes, retrospecting and anticipating
4. Quantitative
5. Application: apply ideas to new situations
6. Analysis
7. Synthesis (9) (10) (1) (2) (6)

C. Critical: The learner makes a judgement of the quality or accuracy of what he has seen, read or heard.(9)

1. Distinguish between fact and opinion (9)
2. Evaluate competency of writer, speaker, experimenter (3)
3. Evaluate ads (9)
4. Understand propaganda (9)
5. Authenticity (6)
6. Relevance (6)

Study Skills: In order to understand and assimilate the information the learner has gained through his observation, reading, or listening certain skills are required in mostly all content areas.

I. Surveying: In this skill the learner previews what is to be learned to gain an overall impression of the whole. This skill sets the purposes for learning and to determine the technique to be used. (6) The learner will be observing, reading, or listening to:

A. Visualize (5)
B. Find illustrations of ideas (5)
C. Generalize (5)
D. Compare with something known before (5)
E. Find relevant ideas (1)
F. Forecast results and draw conclusions (5)
G. Take notes or outline (5)
H. Distinguish between fact and opinion (5)
I. Verify conclusion (5)
J. Examine basic assumptions (5)
K. Follow directions (5)
L. Follow a sequence (5)

II. Select and Evaluate: The learner picks out the important parts of what he is observing, reading or hearing. He must evaluate items in terms of some imposed direction or question. (9)

III. Organize: Understanding and assimilating information requires putting ideas that belong together. This is a complex skill involving word recognition, meaning, selection and evaluation and classifying. (9) Other skills that facilitate organizing are:

A. Previewing
B. Grouping
C. Classifying
D. Outlining
E. Summarizing

IV. Recall: Recalling what is observed, read or hard is an essential skill of learning. If the material has been properly understood and assimilated, the learner will be able to recall it when needed. (9)

V. Locational Skills: Locating information during the learning process is an important and complex skill (9) It includes such subskills as using:

A. table of contents

B. index

C. dictionary

D. encyclopedia

E. cross references

F. graphs, charts, tables, figures

G. bibliographies

H. glossary

I. Chapter headings and subtitles

J. abbreviations and symbols

K. card catalog

L. Reader's Guide

VI. Follow Directions: All subject areas require the fundamental skill of following oral and written directions.

Science Skills: The Learning of science content requires certain special skills. Some are unique to science and others are special applications of skills already mentioned.

I. Skim to determine pattern of writing in science. (7)

1. Enumeration

2. Classification

3. Generalization
4. Problem solving
5. Comparison and Contrast
6. Sequence

II. Classification (9)

III. Explanation of a Technical Process: Many explanations in science involve an oral or written presentation or demonstration in conjuction with diagrams. (9)

IV. Cause & Effect: The learner must determine the cause and effect relationship and then determine how and why causes had effects they did.

V. Instructions for an Experiment: This requires many skills, among which are:

- A. follow written, oral, and demonstrated directions
- B. discriminating observation
- C. careful measurement
- D. careful explanation
    - -data, graphs, charts, etc.
- E. considered conclusions
- F. predicting
- G. inferring

VI. Science Processes (1) Being proficient in the science processes involves a myriad of skills, among which are:

- A. Observing
- B. Using time/space Relationships
- C. Classifying
- D. Using numbers
- E. Measuring
- F. Communicating
    - -using oral and written words. diagrams, maps, graphs, math equations, etc.

G. Predicting

H. Inferring

I. Controlling variables

J. Interpreting data

K. Formulating hypothesis

L. Defining operationally

M. Experimenting

VII. Detailed Statement of fact: (9) In science, facts are more dense than in other content areas. Explanations contain a high percentage of definitions, statement of principles and requires attention to main ideas and supporting details.

VIII. Description Problem Solving: This refers to lessons that take students through problem solving situations.

IX. Abbreviations, Symbols and Equations: (9) Another science skill is one in which students must recognize, understand and use abbreviations, symbols, and equations.

X. Handle Graphics and Illustrative Matter: The learner must be able tc glean accurate information from pictures, diagrams graphs and charts. He must be able to operate in this skill at the literal, interpretive and evaluative levels of comprehension.

XI. Reasoning: The learner must carefully weigh relationships in order to interpret, infer, draw conclusions and predict.

XII. Assimulate: This is a central skill in learning. The learner must take the information he has just gained and relate it to his own personal experience and previously learned knowledge must be woven into the fabric of the learners total knowledge.

XIII. Problem Solving Techniques (3) (11) This skill involves the subskills of:

A. formulating hypothesis'

B. collating evidence

C. evaluating and organizing evidence

D. forming conclusions

E. testing conclusions

XIV. Recognizing sequence of steps: (3) The learner must be able to recognize and pay special attention to the sequence of steps he may be observing, reading about, or listening to in an oral presentation.

XV. Recalling Sequence: Recalling sequence is a special skill that can be enhanced by the learning of certain techniques.

XVI. Taking Notes: The learner must be proficient in taking notes on his observations, readings and oral presentations so he can use them for developing an understanding of the information and assimilate it.

XVII. Developing Summaries and Outlines: This skill is important in organizing what is to be learned. Many of the writing patterns of science (enumeration, classification, generalization, problem solving, comparison and content sequence) are greatly enhanced by summaries and outlines.

XVIII. Learning from error: Learning from error is fundamental in the learning process, especially in science. When an error in making hypothesis, experimenting, controlling variables, observation, etc. is made it is essential that the situation be inspected considered and analyzed so that a new course of action may be attempted.

XIV. Generalizing from details: This skill underlies one of the major goals of science: to search out and define the generalizations behind an overwhelming myriad of detail.

XX. Combination of Patterns: (2) None of the above mentioned skills appears in isolation. Always, it requires the learner to use some combination of these skill patterns.

Language Arts Skills

I. Word Recognition

II. Comprehension

- A. Literal
- B. Interpretive
- C. Critical

Study Skills

I. Surveying

II. Select and Evaluate

III. Organize

IV. Recall

V. Locational Skills

VI. Follow Directions

Science Skills

I. Skim

II. Classification

III. Explanation of a Technical Process

IV. Cause and Effect

V. Instructions for an Experiment

VI. Science Processes

VII. Detailed Statement of Fact

VIII. Descriptive Problem Solving

IX. Abbreviations, Symbols & Equations

X. Handle graphics and Illustive matter

XI. Reasoning

XII. Assimilate

XIII. Problem Solving Techniques

XIV. Recognizing Sequence of Steps

XV. Recall Sequence

XVI. Taking Notes

XVII. Develop Summaries and Outlines

XVIII. Learning from Error

XIX. Generalizing from Detail

XX. Combination of Patterns

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SEPTEMBER REPORT

COMPREHENSION DEVELOPMENT

TITLE IV: PART C
DEVELOPMENTAL GRANT

SCIENCE

Paul Germann

Comprehension

The purpose of Project Capable is "to make each student a more capable learner." Central to this goal is comprehension. The purpose of this paper is to discuss comprehension as it is related to learning, cognitive development and structure, the learning environment, questioning, and comprehension activities. At the outset it should be made clear that all of these elements mentioned above are intimately interrelated and as a result cannot be separated from each other.

Learning can be described as the acquisition of knowledge due to some particular information provided by the environment. To be a good learner the student must receive information from the environment through his senses. This is done primarily through observing, reading or hearing, but also includes touching, tasting and smelling. Once the information is received the student must organize this knowledge into the structure of the knowledge he already possesses. If the new information agrees with the learners internal knowledge structure, it is readily assimilated and becomes part of that knowledge structure. If the new knowledge does not agree or "fit", then it must be accomodated until a good "fit" can be made. This may happen because of a change in the internal knowledge structure, a change in the character of the new information, or both. (11 & 8)

Cognitive Development

Learning requires an interior cognitive structure to process and assimilate new information. It is a structured process that each child begins building from infancy. The building of the cognitive structure proceeds in an invarient order of stages. Piaget divides these stages into: 1) Sensory-motor, 2) Preoperational, 3) Period of Concrete Operations, and 4) Formal Operations.

Typically, a child has developed through the sensory-motor and preoperational stages before beginning school. The period of concrete operations begins at about age 7, or sometime in the early primary grades. Formal thought development will begin at about age 11. These time schedules are variable and each child will develop their thought processes at different rates.

The period of concrete operations consists of nine groupings of basic conceptual processes. These nine groupings are:

1) labeling vocabulary
2) acquisition of rules for transformation
3) long to evaluate validity of cognitive products
4) capacity for attending to move than one channel of input info
5) dramatic increase in immediate memory
6) capacity to inhibit prepotent responses that are inappropriate
7) capacity to classify objects on more than one dimension simultaneously
8) ability to anticipate consequents of acts and a general ability to anticipate the future
9) ability to maintain and sustain attention and set for a problem (10)

Each grouping must be mastered with respect to five characteristics: closure, reversibility, associativity, identity, and special identities.

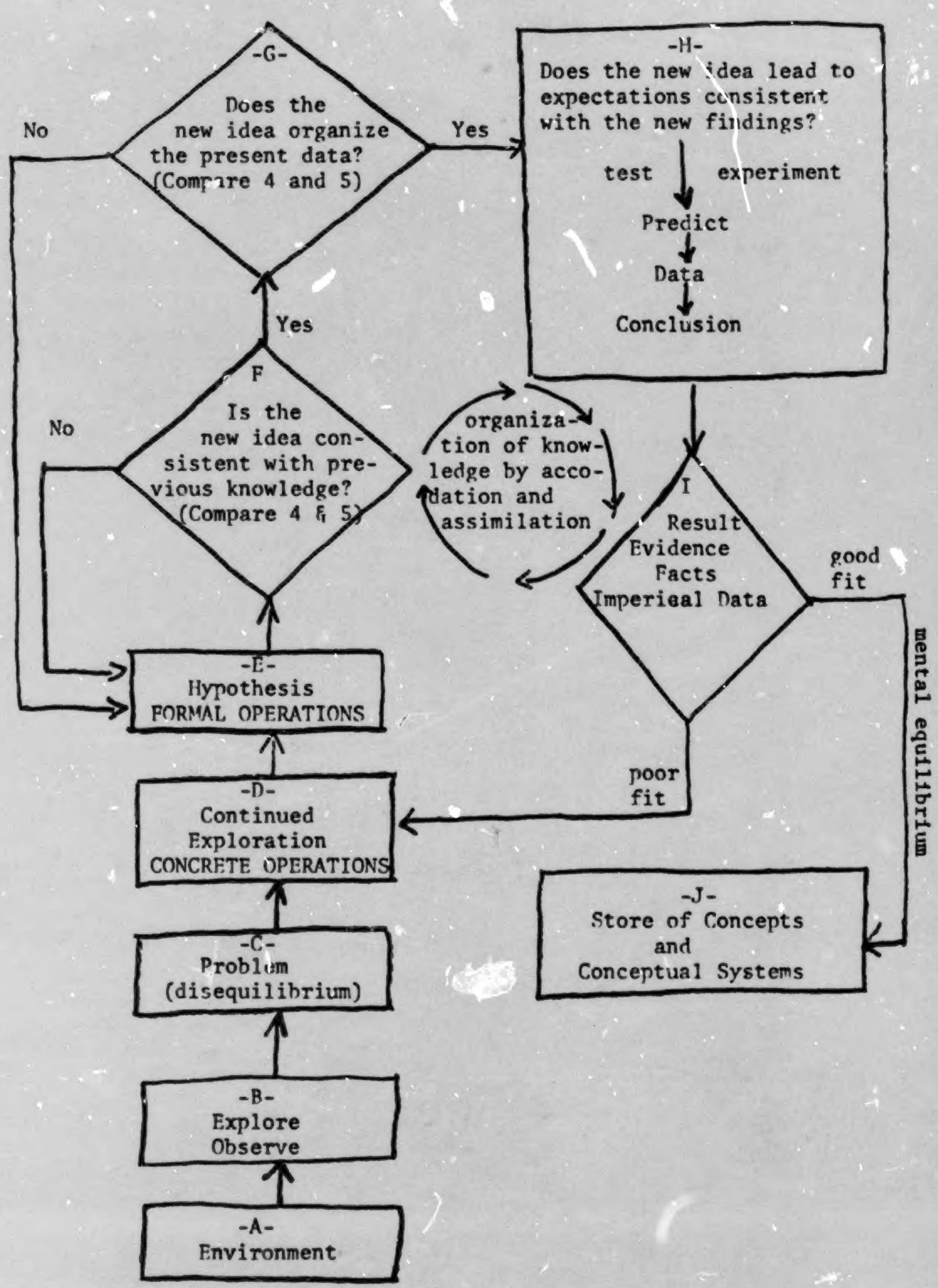
1. Closure: The child must understand that any two operations can be combined to form a third operation
2. Reversibility: For each operation there is an opposite operation that cancels it.
3. Associativity: When three operations are combined it doesn't matter which two are combined first. Also, it is possible to arrive at the same point by different routes.
4. Identity: There is a null operation formed when any operation is combined with its opposite.
5. Special Identities: (a) Tautology: repetition of a classification or relationship does not change it. (b) Iteration: number combined with itself produces a new number.

There are three limitations on the development of concrete thought during this time. First, the operations are oriented toward concrete things and events in the immediate environment. Movement toward a non-present or a potential is limited. Second, the child has to relinquish the physical attributes (such as mass, weight, and volume) of objects and events one by one. Third, each grouping which develops during this period remains an isolated organization and does not form an integrated system of thought.

Usually sometime in junior and senior high school the child has learned the concrete operations and begins developing the structure for formal thought. In this stage the child moves from the concrete and begins to consider his world in theoretical and hypothetical ways. He can consider and compare the possible with the real. The child can think of many possible ways in which things in his world can operate, compare them with what actually exist, criticize the present operation, and then propose better ways of operation.

This formal thought structure develops in three areas. 1) Hypothetical-deductive thinking: In order to discover the real alternatives among the possible requires that the child formulate a hypothesis concerning each of the possibilities and then confirm or reject each. 2) Propositional thinking: The child can take the results of the concrete operations, put them into sentence form and then find relationships among the sentences (or propositions). 3) Combinatorial Analysis: In considering all the possible solutions to a problem the child isolates all the individual factors (propositons or statements) and all possible combinations of factors (hypothesis) that may figure in the solution. (8)

Figure 1
MODEL OF FORMAL THOUGHT STRUCTURE


-G-
Does the new idea organize the present data? (Compare 4 and 5)
No
Yes
-H-
Does the new idea lead to expectations consistent with the new findings?
test
experiment
Predict
Data
Conclusion
Yes
F
Is the new idea consistent with previous knowledge? (Compare 4 & 5)
No
organization of knowledge by accodation and assimilation
I
Result
Evidence
Facts
Imperieal Data
good fit
mental equilibrium
poor fit
-E-
Hypothesis
FORMAL OPERATIONS
-D-
Continued
Exploration
CONCRETE OPERATIONS
-J-
Store of Concepts and Conceptual Systems
-C-
Problem
(disequilibrium)
-B-
Explore
Observe
-A-
Environment

Lawson(14) provides a model as to how a formal thinker gains new knowledge. Figure 1 presents an adaptation of his model. The learner explores and observes (B) his environment (A). This exploration occurs by using his senses. Most often new information comes to him by listening, reading, and observing. The new piece of information will present a problem to the learner and a state of disequilibrium will result (C). The learner may be able to accomodate and assimilate the new idea rather quickly or it may take some time.

The process of organizing the new information into the learners store of knowledge by accomodation and assimilation proceeds according to the following pattern. The learner engages in further observation and exploration (D). In this step he will be considering the concrete characteristics of the new idea. He then enters the phase of formal thought by forming a tentative solution or hypothesis (E).

The hypothesis is evaluated with respect to certain criteria. Is the new idea or hypothesis consistent with the learners previous knowledge (F)? Here the learner compares the new idea with what he already knows and evaluates. If the answer is no, a new hypothesis or idea must be generated. If the answer is yes, the hypothesis or idea is evaluated according to the next criteria: Does the new idea organize the present data (G)? The learner compares the new hypothesis with his observations and explorations and evaluates. Again, if the answer is no a new hypothesis must be generated. If the answer is yes, the hypothesis or idea is evaluated according to the next criteria.

The third criteria is whether or not the new idea leads to expectations consistent with new findings (H). The learner uses the new idea to predict what will happen in a new event. From this he will gain certain data. This new data leads him to draw a conclusion about his new idea or hypothesis. If the facts and evidence (I) show a good fit with his idea, he accepts it, assimilates it into his store of concepts (J) and mental equilibrium is restored.

If there is a poor fit, he needs to re-examine the whole phenomenon or mentally sort through other concepts for another idea to organize the phenomenon and solve the problem. (14, 8, 11, 16)

Learning then is an active process involving a cognitive structure which results in a new organization of knowledge. The result is a change in performance, whether physiological or physchological. New ideas are differentiated and assimilated. (9)

Comprehension and Cognition

Comprehension is closely related to the cognitive process. Comprehension is the ability of the learner to think about what is presented by the environment and to obtain an appropriate meaning. This will depend upon the learner's skill at using his senses to obtain information from his environment and his background of experiences. (20)

Usually the learner obtains this information by reading, listening, or observing. The meaning he will derive from this experience will depend upon his interest and motivation, the purposes he sets (which may not be the same as the author, speaker, or observation experience), his background of concepts, his perceptual skills, and his ability to think at the concrete and formal levels.

Comprehension occurs at many levels. Three basic levels can be described: Literal, Interpretive, and Critical.

1) Literal: The learner understands the direct literal meaning of what is seen, read, or heard in light of the purpose set. The observer understands only the actions and activities he sees. He does not understand why or for what reason. The reader or listener understands only what is "spelled out." He does not make inferences or predict. He cannot judge accuract or relevancy. The learner is operating at the concrete level of thinking. Several subskills enter into literal comprehension:

A. Selecting main ideas.
B. Selecting significant supporting details.
C. Eliminating irrelevant details.
D. Following directions.
E. Following sequence.
F. Classifying convergently.
G. Recording observed information in outline, graph, map, etc.
H. Reading outlines, graphs, maps, charts.

2. Interpretive: The learner thinks beyond the literal to understand in greater depth. He puts together ideas that not related overtly in what he sees, reads, or hears. The learner is now involved in formal thought.

A. Comparison and Contrast.
B. Implication: inferences, relationships, connections.
C. Cause and effect: predict outcomes, retrospecting, and anticipating.
D. Quantitative:
E. Application: apply ideas to new situations.
F. Analysis:
G. Synthesis:

3. Critical: The learner makes a judgement of the quality or accuracy of what he has seen, read, or heard.

A. Distinguish between fact and opinion.
B. Evaluate the competency of a writer, speaker, or demonstrator.
C. Evaluate ads.
D. Understand propaganda.
E. Authenticity.
F. Relevance.

(23, 24, 2, 19, 9, 25)

To comprehend at the interpretive and critical levels, a student must be able to think at the formal level. To expect higher levels of comprehension from a student who has not yet developed formal thought processes is futile.

Researchers are divided as to whether or not cognitive development can be hastened. Many feel that cognitive development occurs at its own pace and little can be done to "speed-up" the process. Others feel that it can be fostered by providing an appropriate environment. The implication of this seems to be that the teacher must be aware of the level of the learner's cognitive development so that appropriate expectations and learning exercises can be provided.

Bruner (5) puts the process of learning in an interesting perspective. He points out that emphasis in the classroom must be put on thinking, not just acquisition and retreival of information. After all, memorizing information is at the literal level of comprehension and demands only concrete thought. It does not challenge the student at interpretive levels of comprehension or formal thought. Bruner suggests that "thinking is the reward for learning." We must not deprive the learner of the reward, but provide opportunities to enjoy.

Instruction

In the classroom where learning, comprehension and thinking take place, the teacher is responsible for instruction. Resnick (18) describes instruction as "any set of environmental conditions that are deliberately arranged to foster increases in competence. This includes demonstrating, telling, explaining and also includes physical arrangements, structure of the presented material, the sequence of tasks and responses to learners actions."

Glaser (12) describes the components of an instructional design. First, the instructor must analyze and describe the skill or concept that is to be learned. He must determine what level of performance of achievement is to be expected. Second, he must determine the present state of the learner. For each individual learner the teacher must know the strengths, weaknesses, styles, and background knowledge, interests and talents. Third, the instructor must provide conditions that will foster the acquisition of knowledge. Fourth, the effects of instruction must be evaluated for short and long term learning, i.e. for providing an effective learning environment.

Carrol (7) provides an analysis of three theories of instruction: naive theory that has been evolved through the history of instruction, the behavior theory based upon postulates of behavior science and the cognitive theory based upon the principles of cognitive development.

1. Motivation: All three theories accept the importance of motivation. Each considers motivation in a different light. The naive theory states that learning occurs best when it is motivated. Motivation directs the attention of the student toward learning. The behavior theory describes motivation as identifying and using drives as reinforcers. The cognitive theory says that motivation will occur when the learner is conscious of the goals.

2. Attention: The naive theory considers this to be a critical variable closely associated with motivation. The behavior theory does not consider this element. The cognitive theory sees attention as important and enhanced by motivation.

3. Result of Learning: The naive theory suggests that the result of learning is some change in internal state. The change is in knowledge of facts, procedures, and behaviors. The behavioral theorists say that the learner learns some overt response to some appropriate stimulus. The cognitive theory says that what is learned is information.

4. Practice and Repetition: The naive theory states that memories will be established and strengthened by practice and repitition. Behavior Theory refers to schedules of reinforcement with respect to time, repetitions of stimuli, responses, and reinforcement. The cognitive theory makes reference to various memory systems and cognitive states occurring during practice and repetition.

5. Feedback: The naive theory speaks of degrees of learning, and until perfect mastery is attained, responses must be checked for their correctness. Behavior theory points to feedback as merely a form of reinforcement. The cognitive theory sees feedback and correction as one kind of information contribution to learning. It is an integral pathway described earlier in this paper. Lawson makes special note of this aspect of learning. He asks us to remember that in reasoning and concept development the wrong answers are important in

developing cognitive framework. Reflective behavior on feedback and the correct and incorrect responses is very important.

6. Reward and Punishment: The naive theory specifies that rewards are administered for the act of learning while punishment is administered to the learner, not the behavior performed. In behaviory theory, reward is of central importance. Positive reinforcement is more effective than negative reinforcement. The cognitive theory sees reward and punishments as another kind of produce learning. As pointed out before by Bruner, thinking and using information to solve problems and answer questions is an important reward for learning.

7. Prévious Knowledge: According to the naive theory, learning builds on prior knowledge and habits. The behavior theory says that is no such thing as prior knowledge, only previously learned behaviors. Cognitive theory recognizes previously acquired knowledge to be an integral part of the learning process. It is necessary to accomodate and assimilate new knowledge into the organized structure of previous knowledge.

8. Nature of Learning: The naive theory sees learning as an active process. The byword is "learn by doing." The behavior theory contends that only overt responses are learned. The cognitive theory states that active learning involves accomodation and assimilation and thought at the concrete and formal levels. Learning is not based upon the irrelevant cues of short term memory.

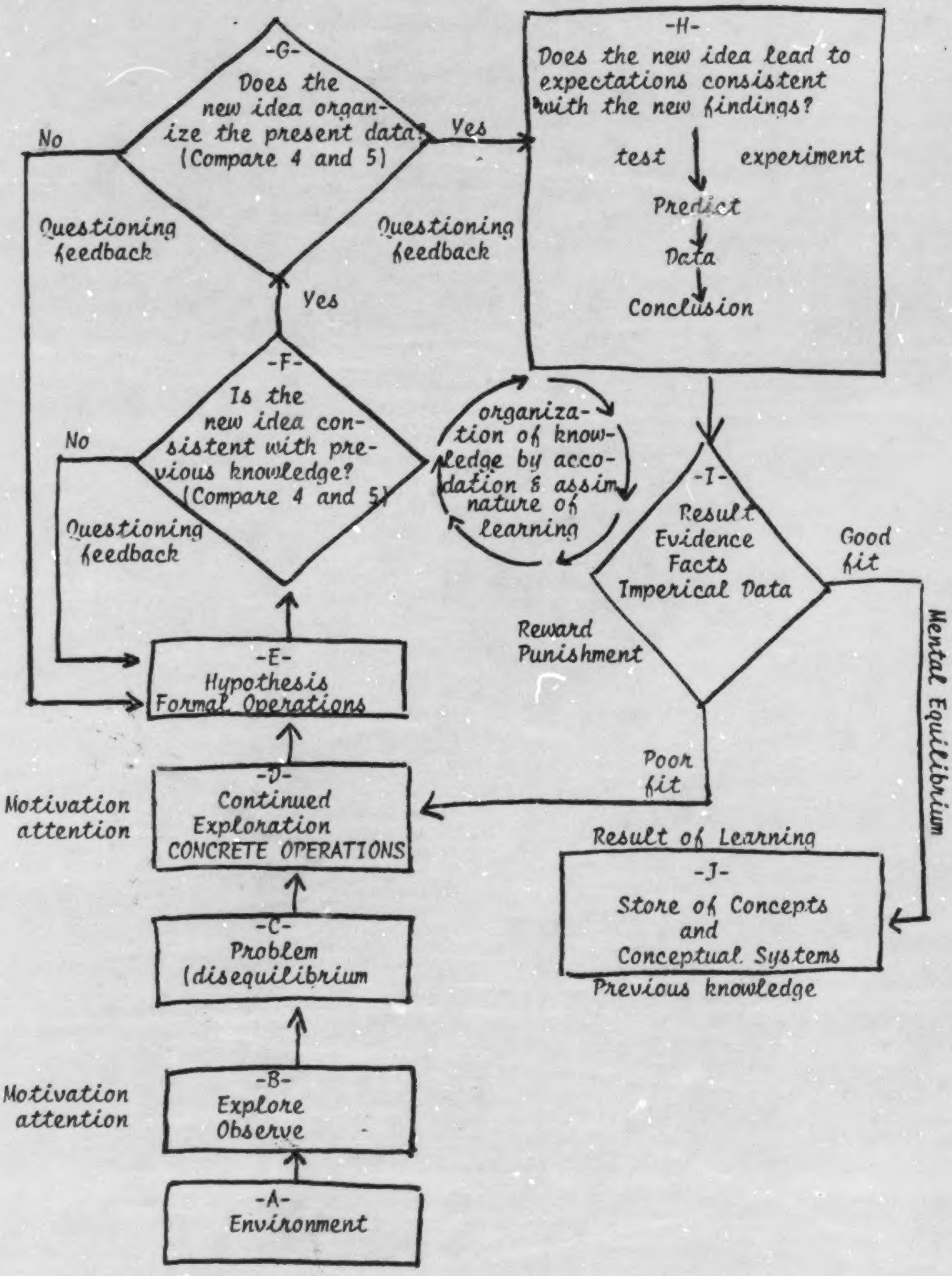
There seems to be basic agreement on many of the aspects of instruction. The instructional activities would be often the same, differing in their explanation as to how the activity causes learning.

The instructional emphasis must be on process, not product. The instructor must concern himself directly with the process through which students will learn knowledge of ideas. These proposals concerning instructional design relate directly to the cognitive process of the learner. As Resnick points out, the teacher is responsible for setting the learning environment. Glaser describes the first steps as being task analysis and pretesting the learner for a number of variables. Based upon this, an appropriate instructional plan can be devised for each student. The principles of instructional design discussed be Carrol relate directly to the model of formal thought proposed earlier. Figure two shows these relationships.

Motivation and attention go hand in hand with the learners explorations and observations of some concept. The students attention must be directed toward the concept and motivated to go through process necessary to accomodate and assimilate it. Questioning of the student draws his attention to his own mental disequilibrium with respect to the concept. The student must then be motivated to consider hypothetical solutions to that disequilibrium and to look to his previous knowledge to see if its consistent. This can be done by questioning. The result is new feedback information. Next, the hypothesis is applied to all the known data to see if it lends organization to that data. Again, new feedback information is gained.

Through questioning, the student applies his hypothesis to a new case and the resulting feedback provides more data bearing on the acceptibility of the student's new idea. Any reward and punishment provided in the classroom becomes additional data. Finally, an acceptable hypothesis is formulated, mental equilibrium is regained and the new idea is assimilated into the learners store of knowledge.

Figure 2
Cognitive Development & Learning


-G-
Does the new idea organize the present data?
(Compare 4 and 5)
No
Yes
Questioning feedback
Questioning feedback
-H-
Does the new idea lead to expectations consistent with the new findings?
test
experiment
Predict
Data
Conclusion
Yes
-F-
Is the new idea consistent with previous knowledge?
(Compare 4 and 5)
No
Questioning feedback
organization of knowledge by accodation & assim nature of learning
-I-
Result
Evidence
Facts
Imperical Data
Good fit
Reward
Punishment
Mental Equilibrium
-E-
Hypothesis
Formal Operations
Poor fit
Motivation attention
-D-
Continued
Exploration
CONCRETE OPERATIONS
Result of Learning
-J-
Store of Concepts and Conceptual Systems
Previous knowledge
-C-
Problem
(disequilibrium
Motivation attention
-B-
Explore
Observe
-A-
Environment

Questioning

Questioning, then, is central to developing comprehension through the use of formal thought. The questions must challenge students beyond the literal level, for that requires only concrete thinking. The questions must be interpretive and critical, thereby facilitating formal thought, a better understanding of the concept, and assimilation by the learner.

Sinatra (21) suggests the order of the questions is also important. "When posing in a given sequence, this expresses a strategy of thinking, and it is this sequence of questions that determine the quality or level of thought processed by the student."

Weinstein (27) points out that experimental results show that "successful learners use meaningful elaboration strategies in preference to more rote, or superficial strategies." By elaboration strategies she meant relating material to previous knowledge, creating logical relationships within the material, drawing inferences and drawing implications. Each of the elaboration techniques is directed to some phase of cognitive structure, to interpretive levels of comprehension, and is enhanced by questions at the interpretive level. Weinstein goes on to point out that evidence shows that learners taught elaboration techniques will be more successful.

Carney (6) gives us several ideas on how elaboration techniques (he calls them "organizing behaviors") can be taught in order to facilitate comprehension in the content areas.

1. Model the expected behavior for the student by taking them through the thinking process.
2. Use graphic organizers or structural overviews.
3. Use vocabulary words as advanced organizers for reading. Vocabulary words represent important concepts.
4. Graphic displays of concepts or vocabulary to show realtionships.
5. Model inferences. Choose from a list of inferences the one that is most appropriate.
6. Use imbedded organizers, i.e. comments put with the text to call students attention to main thrust of the exercise.

In each of these, the interaction between teacher and student will most often be question and answer.

Andre(1) makes four important observations concerning questioning. First, teachers oral questions are typically answered by only one student at a time. This provides maximum benifit only to that student, less benefit to those who answer covertly, and no benefit to those who aren't responding at all. He suggests using adjunct questions. These are questions that are inserted into the text to be read, or that precede or follow the text. Current data strongly supports the conclusion that higher levels of adjunct questions direct the student's attention to more of the material and thus recall information better. The questions encourage formal thought and better comprehension.

Second, questions must be frequent, direct the students attention to the material to be learned, and be specific in nature, not general. By directing the learner to particular kinds of information, the question leads the learner to set up a strategy for processing the information.

Third, students who respond to higher level questions during their study are more successful at answering different higher level questions on the post test. The verbatim questions encourage the learner to memorize the exact words of the text while comprehension questions demand that the learner understand a paraphrased version of the message or to apply the concept or principle.

Fourth, if adjunct questions are too difficult, they probably won't increase learning but produce frustration.

Robinson(19) identifies four factors which will influence comprehension.
1. The nature of the learner: each learner has a unique blend of background knowledge and experiences, talents, learning skills, motivations and purposes. This will obviously affect the way that he cognitively understands and assimilates the material.

2. The nature of the material: the material may be in written, spoken, or observation form. It may vary in difficulty, concept density, or assumed level of background of knowledge.

3. The nature of the purposes for reading: The purposes may be set by the author, speaker, or demonstrator, or may be set by the learner or teacher. These purposes may coincide or they may not.

4. The means used for measurement: The learner will comprehend the information in light of how he expects he will have to apply it at some future time.

Lucking (15) lists several guidelines for comprehension questions.

1. Phrase the questions to be clearly understood.
2. Don't answer you own questions.
3. Allow time for the student to consider the questions.
4. Don't ridicule wrong answers.
5. Don't ask the obvious.
6. Encourage open debate.

If we expect students to be competent learners, we must help them develop effective reading comprehension skills, listening comprehension skills, and observation skills. As might be expected, questioning will play an important role.

Reading Comprehension

As Robinson (19) points out "the printed words mean nothing unless the reader brings meaning to them." This meaning is arrived at through comprehension at all levels. At the literal level the reader identifies pertinent information. When the reader looks for relationships among pieces of information to determine the authors meaning, he is operating at the interpretive level. As part of the cognitive and comprehension process the reader looks for ideas in his experience or other reading which are related to the author's meaning. He is attempting to apply what he has read.

Most classrooms and texts overemphasize literal comprehension. The facts of the subject matter should be the means to the end, not the end itself. The goal in the classroom should be comprehension which will lead to assimilation of concepts into the learner's background of knowledge through formal thought.

Teachers need to guide students if they are to become aware of levels of comprehension. Students need to be taught to comprehend and think and they need opportunities to practice. The teacher must be aware of skills related to reading comprehension. Shepherd (20) suggests the following list:

1. Read for a well defined purpose.
2. Distinguish main ideas and supporting details.
3. Determine the author's purpose.
4. See author's organization.
5. Vocabulary.
6. Relate the reading to the readers experience or background presented in class.
7. Handle complex sentences.
8. Visualize what is read.
9. Understand figurative expressions and subtle meanings.
10. Weigh evidence, draw valid inferences and conclusions.
11. Interpret graphs, tables, maps and diagrams.

The Reading Lesson

The reading lesson can take many forms and involve the above mentioned elements in different ways. Thomas and Robinson (26) suggest a list of components for a good reading lesson:

1. Capture interest.
2. Use or provide a background of experience.
3. Help students have a purpose.
4. Help students accomplish their purpose.
5. Preteach vocabulary and concepts which would otherwise block their understanding.
6. Provide when appropriate and possible, reading materials on a variety of suitable levels.

Piercey (17) suggests the following structure for a reading lesson. She breaks the lesson into two parts: the briefing and questioning. The briefing consists of introducing vocabulary, teaching concepts, helping students set a purpose, and transferring enthusiasm to the student. After or during the reading, questioning takes place. Questioning is a way of understanding the author. It is important to formal thinking and higher levels of comprehension. The teacher must demonstrate how the questioning is to be done and provide opportunities to practice.

Another technique is PQ4R or other similar techniques. PQ4R stands for Review, Question, Read, Reflect, Recite, and Review. The preview consists of an overview of the material to be read. This preview is done by skimming the assignment. The student reads the title, introduction, main headings, italics and bold faced words, and summary. He also studies the pictures illustrations, graphs, and charts.

In the questioning phase, the teacher raises questions to guide the careful reading to follow in terms of the study purposes. Besides directing the student's attention to important features of the reading assignment, the questions can also serve to enhance comprehension and serve as a guide through formal thought processes.

Now the student reads the selection, keeping the questions in mind. Following the reading is a period of reflection. The reader reflects on what he has read and the questions. Now he must organize the ideas. During this phase, the formal thought processes attempt to assimilate the material.

Recite will reinforce what has been learned. This may be done orally or written, by the student alone or in class. Questioning by the teacher at this stage fosters further formal thought and comprehension and improves long term memory of the information. A final review brings all elements together and provides an overview of the total picture.

Still another instructional strategy for comprehension is reading guides, such as those outlined by Herber.(13) These utilize the adjunct questions suggested by Andre. In one form of the reading guide, the student is provided with statements derived from the text which are at each level of comprehension. First are several literal statements, then interpretive and application. The student must identify the parts of the text which produces each statement. Detailed analysis of the exercise will follow in the classroom.

A second reading comprehension guide refers to page and paragraph in the text. After reading each designated paragraph the student must choose from a list of several statements the one that gives the correct interpretation.

Yet another form of the reading guide asks questions of various comprehension levels concerning paragraphs in the text. The questions may or may not indicate the page and paragraph which will provide the information necessary to answer.

Listening and Observing Comprehension

Listening and observing involves all of the elements of reading if comprehension is to be achieved. There is a greater burden on the speaker or demonstrator to provide certain elements in a clearly defined manner since the learner does not have a permanent text of the information to work with.

The learner cannot preview to get an overview, anticipate vocabulary, set purposes, or raise questions, nor can he review when the learning experience is done. Yet, if the learner is to be effective, these must be present. The classroom teacher must provide these when conveying information in the lecture or observing situations. In informal learning situations, the learner must be aware of the need to establish these and other comprehension elements as he undergoes the experience.

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Project CAPABLE

CLASSROOM ACTION PROGRAM:

AIM: BASIC LEARNING EFFICIENCY

"to make each student a more capable learner"

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OCTOBER REPORT

VOCABULARY DEVELOPMENT

TITLE IV: PART C
DEVELOPMENTAL GRANT

SCIENCE

Paul Germann

The goal of Project Capable is "to make each student a capable learner". To be a capable learner a student must have certain basic learning skills. Central to learning is vocabulary development. It is through vocabulary that we think and communicate. It is the medium through which ideas are passed from one individual to another.

Types of vocabulary

Four levels of vocabulary can be described: Speaking, reading, writing and listening.(14) At the high school level, the largest of these is the reading vocabulary, at least for most students. The next largest is listening vocabulary followed by writing and then speaking.

Each of these four levels can be divided into four categories. The first category the general vocabulary which is represented at each level. These are words used for general communication, thinking, feeling, and doing. In this category, we may also include connotative vocabulary, words used in some symbolic sense. The second category is technical vocabulary. This category includes general words with precise meaning within a particular subject and technical terms of the subject. The third category of vocabulary is proper nouns. These are names of specific objects, persons or events, rather than move general names. The fourth category consist of connectives, flagged, and joined words.(12&13) These words do not have meanings by themselves, but add meaning to a word, phrase or sentence. The words in the first two categories name concepts, whereas, the third and fourth do not.

TYPES OF VOCABULARY

		Reading	Listening	Writing	Speaking
Conceptual	General Vocabulary: (a) general communication & thinking (b) connotative meaning				
	Technical Vocabulary: (a) general words with precise meaning (b) technical words				
Non-conceptual	Proper Nouns				
	Flagged and joined words				

A person's vocabulary can be considered in two dimensions. In one dimension is his reading, listening, writing and speaking vocabulary. In the other dimension is his general vocabulary, technical vocabulary, proper nouns, and flagged and joined words.

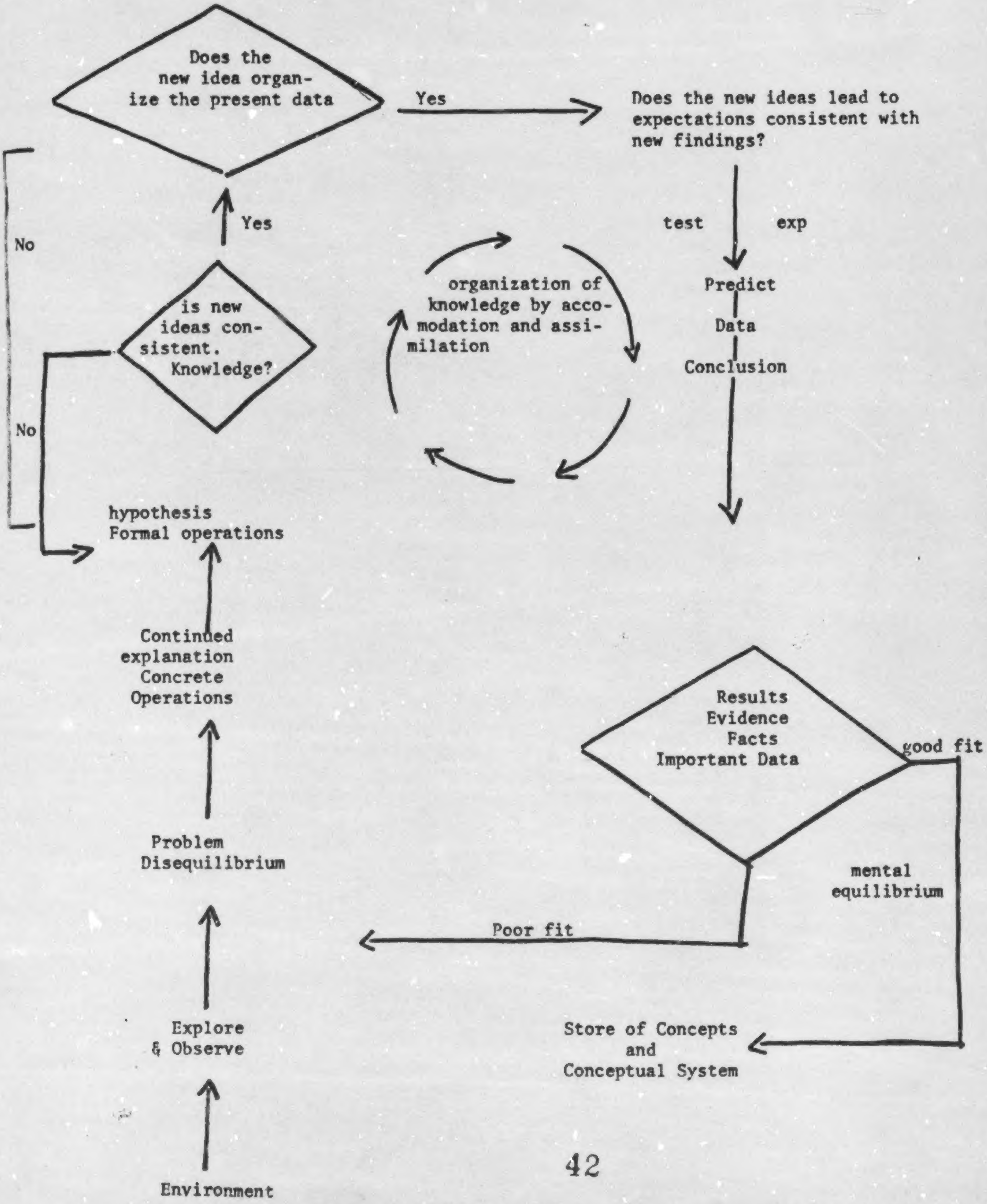
Definition of Vocabulary Learning

Vocabulary learning is the acquisition of words and allusions which permit quality expression, i.e. to be able to express our thoughts and feelings in the best possible manner.(14) More specifically, in our content areas, vocabulary consists of the language of the subject which permits the learner to communicate ideas and think abstractly about the subject matter.(13) The learner must develop versitility and depth of understanding when using words for thinking, discussing, listening, writing, or reading about a particular content area. (1)

Vocabulary development is more than the learning of isolated lists of words. The acquisition of words and groups of words within the larger contextual language must be stressed. There is a close relationship between vocabulary development, conceptual development, cognitive development. As a matter of fact, a concept is the basis for vocabulary development and is basic to comprehension. The cognitive process requires the use of language. Vocabulary is the cornerstone of concept development, accultration, articulation and all learning. (14) So strong is this relationship that both intelligence and success within a discipline are strongly correlated to vocabulary knowledge. (14)

Vocabulary & Cognitive Process

Vocabulary words represent concepts, or, to put it another way, the meaning of a word is a concept. By concept we mean an idea which represents the similarities in otherwise diverse objects, situations, or events. (15) The process of conceptualization is a cognitive process. As such, it requires an experience base to relate to. A new concept causes mental disequilibrium. The learner then accomodates and assimilates the concept. This is accomplished by first considering the concept at the concrete level. Once a few concrete examples have been experienced the learner begins to generalize. He will test his generalization to see(1) if it is consistent with previous knowledge; (2) if it organizes the present data, and (3) if it leads to expectations consistent with new findings. If the generalization fails any of the tests, a new generalization will have to be formulated. If it passes these tests, the generalization, or concept, is assimilated and stored in the learners background of knowledge. The concept never stops growing. Whenever the learner meets the concept in new ways, it is expanded and revised. The concept is now a tool used to organize, accomodate, assimilate, and categorize new information.


Does the new idea organize the present data
Yes
Does the new ideas lead to expectations consistent with new findings?
No
Yes
is new ideas consistent. Knowledge?
No
organization of knowledge by accomodation and assimilation
test
exp
Predict
Data
Conclusion
hypothesis
Formal operations
Continued explanation
Concrete Operations
Results
Evidence
Facts
Important Data
good fit
mental equilibrium
Problem
Disequilibrium
Poor fit
Explore & Observe
Store of Concepts and Conceptual System
Environment

Vocabulary and Concept Development

Since vocabulary development is a cognitive process and the meaning of a word is a concept, we can describe a pattern of concept development. Dechant (5) offers us a model of the characteristic pattern of the development of concepts. He distinguishes sex levels: I. Perception, II. Perceptual Schemas, III. Contextual Perception, IV. Perception of Differences, V. Conceptualization, VI. Categorization.

Level I: Perception - The learner's first experiences are with concrete objects, persons, or events and their attributes. He is able to discriminate one object from another, but each object shares no common characteristic with any other object. With repeated experiences the learner gains new meanings.

Level II: Perceptual Schemas - The information gained from the concrete experiences is internalized. The learner begins to look for organization which will allow him to recognize when future experiences are the same. He is beginning to recognize similarities among objects and organizes them accordingly.

Level III: Contextual Perception - Additional meaning is given to objects because they are characteristically associated with other objects or experiences. The emphasis is still on similarity between objects. Since there is little discrimination between objects, overgeneralization is frequent at this level.

Level IV: Perception of Differences - The learner now begins to make accurate discrimination of essential and non-essential characteristics. He now learns when a difference in objects or events matters and changes the concept and when a difference does not change the concept.

Level V: Conceptual - The concept is the product of abstraction. The learner now percieves the sameness among objects, those characterics which do not change within the concept, and the differences which are allowed by the concept.

Level VI: Categorization - The learner can now use the concept to group objects or experiences into classes based upon the essential and non-essential characteristics.

In the biology classroom, when students first consider the concept "life" they consider their experiences with living objects. In answer to the question "What is life?" they respond "It is something that moves," "It is something that reproduces," or "It is something that grows." These are the internalized products of their concrete experiences with living things. They have recognized certain similarities among living things which allows them to identify objects as being living or not. At this point, students are overgeneralizing and as a result, can be misled into describing some non-living object as having life (a waving shadow in a dark bedroom), or some living object as not alive (a sponge or lichens). Also, they are describing characteristics of something that has life (moves, reproduces, grows, needs food, etc.), but are not describing what life is. Further experiences with the word life in a variety of contexts clarifies the essential and unessential attributes of the words and the teacher can bring students closer and closer to the understanding that life is a state of being in which energy is used to maintain a complex organized system. Having developed this concept, it can now be used to decide whether an object should be classified as having life or not.

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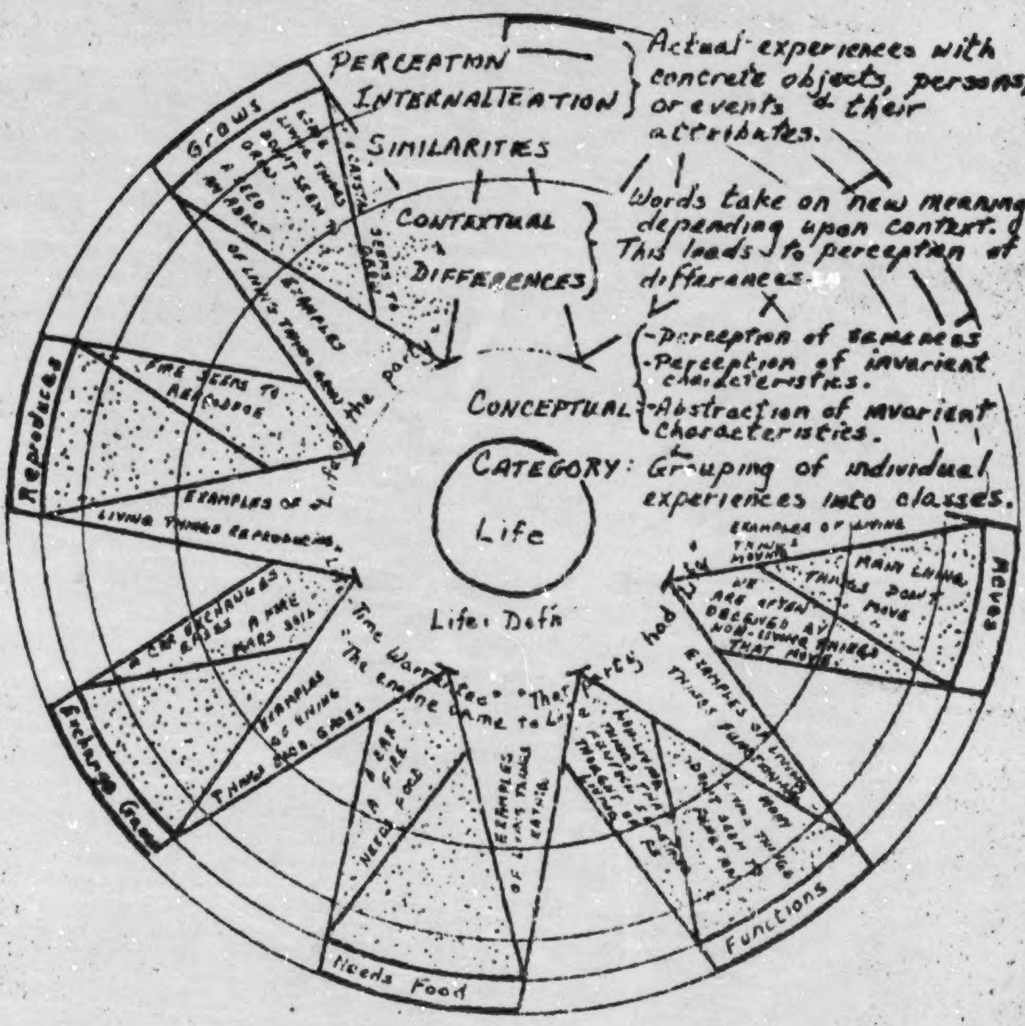
CONCEPT DEVELOPMENT


PERCEPTION
INTERNALIZATION
Actual experiences with concrete objects, persons, or events & their attributes.
SIMILARITIES
CONTEXTUAL DIFFERENCES
Words take on new meanings depending upon context. This leads to perception of differences.
CONCEPTUAL
-Perception of sameness
-Perception of invariant characteristics.
-Abstraction of invariant characteristics.
CATEGORY: Grouping of individual experiences into classes.
Life
Life: Defn
Grows
Reproduces
Exchange Gases
Needs Food
Functions
Moves
FIRE SEEMS TO REPRODUCE
EXAMPLES OF LIVING THINGS REPRODUCING
A CAR EXCHANGES GASES A FIRE HAS SOIL
EXAMPLES OF LIVING THINGS EXCH. GASES
A CAR A FIRE NEEDS FOOD
EXAMPLES OF LIVING THINGS EATING
EXAMPLES OF LIVING THINGS FUNCTIONING
EXAMPLES OF LIVING THINGS MOVING
MANY LIVING THINGS DON'T MOVE
WE ARE OFTEN DECEIVED BY NON-LIVING THINGS THAT MOVE
EXAMPLES OF LIVING THINGS GROW
"Life of the party"
"Time wasted"
"The engine came to life"
"That party had life"

In learning concepts the person attempts to simplify the world about him by grouping objects, ideas and experiences into concepts. The first step of conceptualizing is actual experience with the concrete (outermost ring). Names are attached to objects. The experience is then internalized (second ring). At the next level the learner is able to perceive similarities but not differences. As a result there is a tendency to overgeneralize and mistakes are made. At the contextual level the learner begins to see differences (shaded triangles) as well as similarities (white triangles). The use of the concept in many contexts enables the learner to see differences and similarities as well as to identify the invarient similarities in the concept. This leades directly to conceptualization based upon the invarient similarities. The concept can now be used to categorize new experiences.

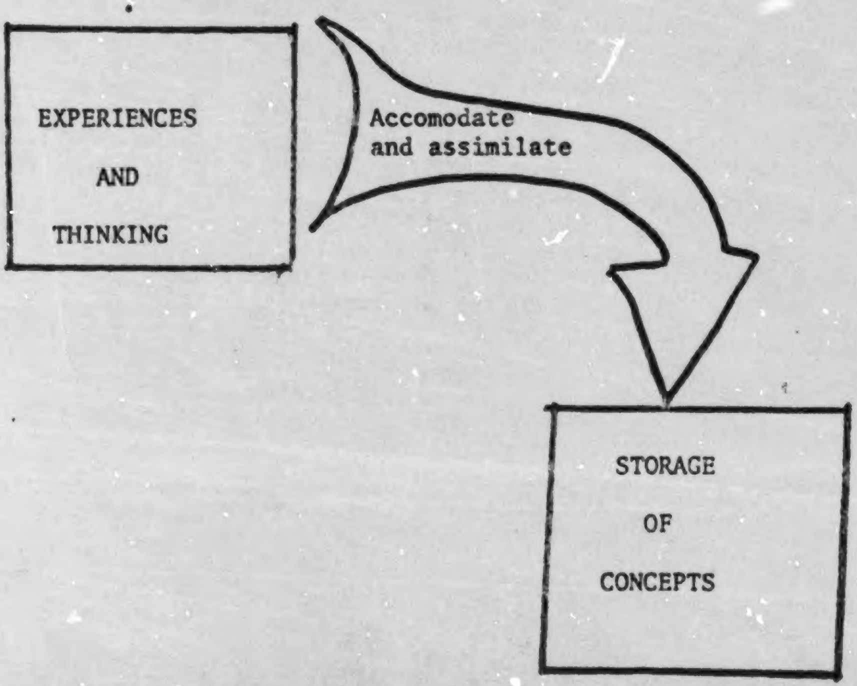
Concept Development - Another Model

Another model for concept development (8) describes 3 levels of formation. At the lowest level, the specific level, the word is associated with one object, event, or person. As the learner's experience increases the word is seen associated with other objects, events or persons. The learner begins to discern certain common characteristics which are shared by all those things named by that word; this level of assigning characteristics to the word is the Functional Level. The learner can now use the word in meaningful ways. He still will make mistakes using the word, since there is a tendency to overgeneralize at this level. With more experience, the learner begins to understand which characteristics are absolutely necessary to be able to use the word and which ones are not. This is the Conceptual Level. At this time the word no longer is used at the specific level but is in the form of an abstraction. The word can be used in a variety of contexts. The abstraction can be used to classify new persons, objects, or events with respect to the word.

Consider the development of the concept (or principle) photosynthesis. At the specific level we can consider the prefix "photo" in other words that the students know (photograph, photoelectric cell). They have some knowledge of these words from their own background. The root "synthesis" can be approached in the same manner (synthetic, synthesize). A meaning can now be given to the word photosynthesis in a very limited, specific, concrete way. Through further activities, new layers of information are added to the word to give it functional meaning. Through experiments, we develop a list of necessary materials for photosynthsis and also its products. Next, we view the word as denoting a process which occurs in two phases. We now divide materials and products into two parts: The details of each phase are studied, the process is compared to complex chemical machine, and a summary diagram is designed. By this time, the student has reached the conceptual level of understanding.

Concept Development and the Cognitive Process

Concept development, then, proceeds from the concrete to the abstract. As the concept develops it follows the pathways of the cognitive structure described earlier. The initial experience with objects or experiences described by the concept are described in our cognitive model as the stage of explanation and observation. As a result of this interaction with the objects, the learner attempts accomodate and assimilate the information through some sort of internal organization. This poses a problem for the learner and mental disequilibrium results. Further experience with related objects and experiences are internalized and the learner begins to see similarities among the objects. The learner is still operating at a concrete level. Next the objects are experienced within their various contexts and this causes the learner to discern not only similarities, but also differences. It is at this point that the learner begins to make hypotheses as to what the essential and non-essential characteristics are. These hypothesis are tested until an appropriate generalization is reached. This generalization can now be used, as part of the learner's background of knowledge to classify new objects or experiences. Each time this is done, the concept undergoes change, however slight.



According to Praget, the development of this cognitive process occurs in stages. Preschool stages include (1) sensory motor period (age 0-2) and part of (2) period of preoperational thought (age 2-7). This second period is divided into 2 distinct phases: preconceptual (age 2-4) and intuitive (age 4-7). By this time a child begins school, the preconceptual phase is completed and he has begun the intuitive phase. During the elementary grades a child is in the (3) period of concrete operations (age 7-11). A child does not begin to develop the pathways of the cognitive process as described earlier until he enters the (4) period of formal operations (age 11 & up). This begins sometime in the junior high grades.

The consequences of this relationship between concept development and the cognitive process is that teaching and learning must be related to the student's level of intellectual development. Since concept learning requires abstract thought, we cannot have the same expectations of children who are in the period of concrete operations as those who have developed formal operations. As DeCecco (4) points out, "in the period of concrete operations, the child's thinking is oriental toward concrete objects in his immediate environment; he relinquishes the physical attributes of objects one by one, and each grouping remains an isolated organization. In the period of formal operations, the child's thought concerns the possible as well as the real. He is capable of hypotheticodeductive and propositional thinking."

As a result, the child in the period of concrete operations can learn concepts which require the classification of concrete objects and events. Those children in the period of formal thought can handle principles as well as concepts since principles, as if then statements, are a form of propositional and hypothetic deductive thinking. These children can engage in scientific thought while the younger child would not ordinarily be capable of thought at this level. While teaching concepts [illegible] prossible during both of these periods, the teaching of principles proceeds more easily during the later period. (4)

Concepts and Principles in Education

DeCecco (4) describes several ways in which concepts are useful in the students education.

1. Concepts reduce the complexity of the environment. In an environment filled with an overwhelming number of stimuli, similarities and differences, concepts and principles enable a student to make sense of world he would otherwise have difficulty coping with.

2. Concepts help us to identify the objects of the world around us. Identifying objects in our environment involves placing an object in a class. This reduces the complexity of the environment. Also, the ability to form concepts depends upon concepts already learned and will influence the learning of future concepts.

3. Concepts and principles reduce the necessity of constant learning. Once we have learned the attributes of a concept, we can use it to classify new objects, events, or persons. This allows a student to progress through a discipline and acquire increasing amounts of knowledge.

4. Concepts and principles provide direction for instrumental activity. Concepts and principles allow us to know, in advance, the actions we can take. We are able to make decisions based upon our ability to place persons, events, or objects into the appropriate class. This is important in problem solving.

5. Concepts and principles make instruction possible. As we move through our schooling from grade 1 to 12 and then perhaps on into college and post graduate study, instruction becomes more and more verbal with less dependence on concrete objects. This is due not only to increasing development, but also because the assumption is made that the student has an increasing store of concepts and principles that can be recalled simply by using the word that refers to them.

The Nature of Concepts

DeCecco (4) describes a concept as a class of objects, events, or persons which have common characteristics. They represent human attempts to classify and simplify our environment. He describes concept attributes as distinctive features of a concept that vary in value, number and dominance. Value is the particular variation an attribute may undergo. The number of attributes varies from concept to concept. Dominance refers to the fact that some attributes are more obvious than others.

The Teaching of Concepts

Step 1. Describe the Performance Expected of the Student After He Has Learned the Concept.

In the case of concept learning, we should expect students to correctly identify new examples of the concept. An appropriate expectation would not be to give a definition of the concept. The purpose of this performance objective is: (1) to determine the needs of instruction; (2) to assist both teacher and student assess performance and determine when learning is complete.

Step 2. Reduce the Number of Attributes to be Learned in Complex Concepts and Make Important Attributes Dominant.

The teacher must analyze the concept to determine values and number of attributes to present to the students. In complex concepts some attributes may have to be ignored or arranged into patterns. Besides determining the number and dominance of attributes the teacher must also determine the relationships between concepts.

Step 3. Provide the Student with Useful Verbal Mediators.

The student must have the necessary verbal associations before he can begin the consideration of a concept. There is considerable evidence to show that the learning of a concept is considerably enhanced by the learning of certain names or labels.

Step 4. Provide Positive and Negative Examples of the Concept.

This step is a major necessary condition of learning. Enough positive examples, those which contain the attributes of the concept, must be presented to represent the range of the concept. The negative examples, those which do not contain attributes, will be determined largely from the experience of the teacher. The teacher attempts to provide negative examples which typically confuse students.

Step 5. Present the Examples in Close Succession or Simultaneously.

This step can be accomplished in three ways. The most successful method is *simultaneous presentation*. New examples are shown with all previous examples in view. *Focus condition* is somewhat less effective. Here, two examples are presented together - the focus example (positive) and the new example (positive or negative). Third, and lest effective of the three, is *successive presentation* in which one example is shown at a time for about 20 seconds and then removed.

Step 6. Present a New Positive Example of the Concept and Ask Students to Identify It.

Both contiguity and generalization are provided by this step. Generalization is emphasized. The teacher is now concerned with verifying, preserving, and extending the students ability to make the appropriate conceptual response to a new but similar pattern of Stimuli.

Step 7. Verify the Student's Learning of the Concept.

The teacher should present several new positive and negative examples of the concept and ask the student to select only the positive.

Step 8. Require the Student to Define the Concept.

Some concepts in science, mathematics and other disciplines are difficult to describe in words. It cannot be assumed that if a student understands a concept, that he can define it. It is necessary to teach students how to formulate definitions, especially for difficult concepts.

Step 9. Provide Occasions for Student Responses and the Reinforcement of These Responses.

In steps 4 through 8 it is necessary that student's make responses and obtain feedback that reinforce the appropriate responses.

The Nature of Principles

A principle is a statement of the relationship between two or more concepts. Principles are sometimes called rules or generalizations. For example, "all men are created equal" is a principle. Four concepts are related: all, men, created, equal. It is sometimes useful to think of statements of principles as if-then statements. The above example would read "if you are a man, then you have been created equal to all men." The advantage of this kind of phrasing is that it indicates the ordering of the component concepts.

Often a vocabulary word refers to a principle. In biology such words as life, cell, photosynthesis or respiration refer to principles. DeCecco(4) describes 8 steps to a teaching model for principles.

Step 1. Describe the performance expected of the student after he has learned the principles.

This step allows the student to assess his own performance and self reinforcement of learning.

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Step 2. Decide and indicate which concepts or principles the student must recall in learning the new principles.

The teacher must analyze the concept to determine what the component concepts are, how to which concepts the students already know, how to teach new concepts, and how to show the relationships between these concepts to describe the-principle. There is not only a hierarchy of concepts to be considered (one concept is often dependent on the learning of another concept) but also a hierarchy of principles. If a teacher is to be effective in teaching principles and the component concepts, this task analysis must be done. The teacher must ask himself at each step "What does the student need to know in order to learn this concept or principle?" The results of this task analysis can be usefully described by concept maps which show the relationships between concepts and principles.

Step 3. Assist the students in the recall of component concepts.

Not only is there the recall of previously learned concepts, but also the learning of new concepts is often necessary. This is especially true in content areas in which students have had limited previous exposure.

Step 4. Help the students to combine the concepts in the proper order.

Step 5. Require the student to demonstrate the principle fully.

The student must not only be able to choose correctly examples which illustrate the principle, but he must also actually demonstrate the principle in some way.

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STRUCTURE DIAGRAMS

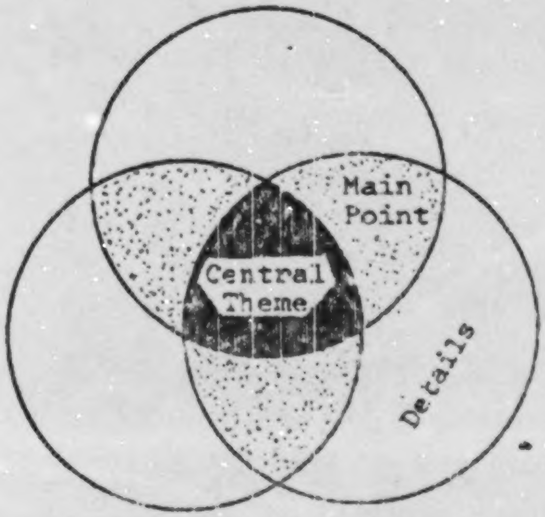
The structure of a schema, principle or concept is dependent upon the relationships among the parts, as well as the parts themselves. Illustrated here are several possible structure patterns which graphically demonstrate the organization of parts and various relationships among the parts.

OUTLINE

I. General topic
    A. Main point
        1. Detail
            a. Subdetail
            b. Subdetail
        2. Detail
            a. Subdetail
            b. Subdetail
            c. Subdetail
        3. Detail
            a. Subdetail
            b. Subdetail
    B. Main Point
        1. Detail
            a. Subdetail
            b. Subdetail
            c. Subdetail
        2. Detail
            A. Subdetail
etc.

The outline form of structure illustrates organization based on one direction with descending importance. This structure might be used where the material would progress in a time sequence or step by step.

OVERLAPPING STRUCTURE



The overlapping form of structure illustrates organization where the parts intersect and overlap with each other, and where the organization is not made up of clearly separate ideas. The areas of overlap illustrate the merging and blending of ideas which form higher and higher levels of meaning.

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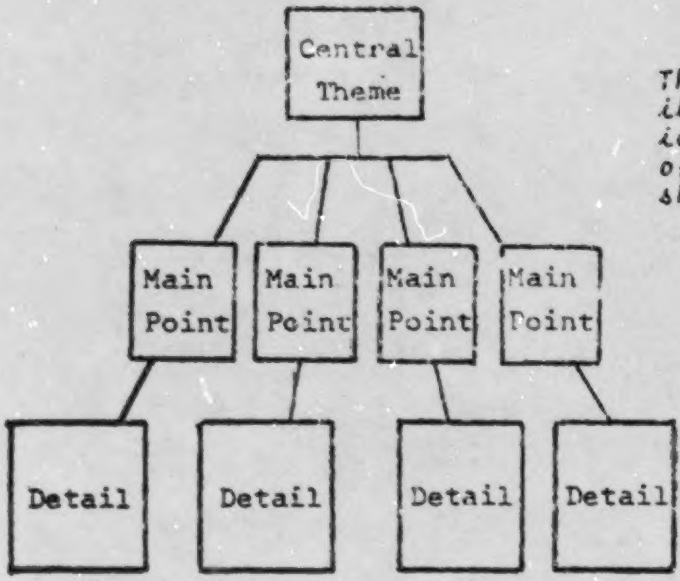
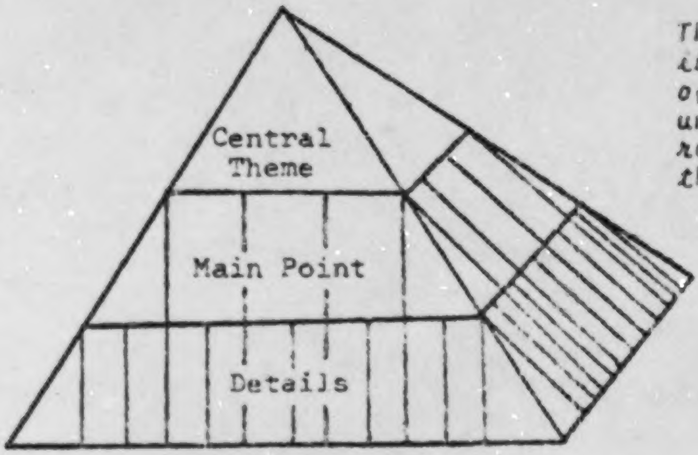
PYRAMID


Central Theme
Main Point
Main Point
Main Point
Main Point
Detail
Detail
Detail
Detail

The pyramid form of structure illustrates different directions of support and the unity of ideas through the relationship of each part to the whole.

PYRAMID


Central Theme
Main Point
Details

The pyramid structure diagram illustrates several directions of support and identifies the unity of the ideas through the relationship of each part to the whole.

RADIAL

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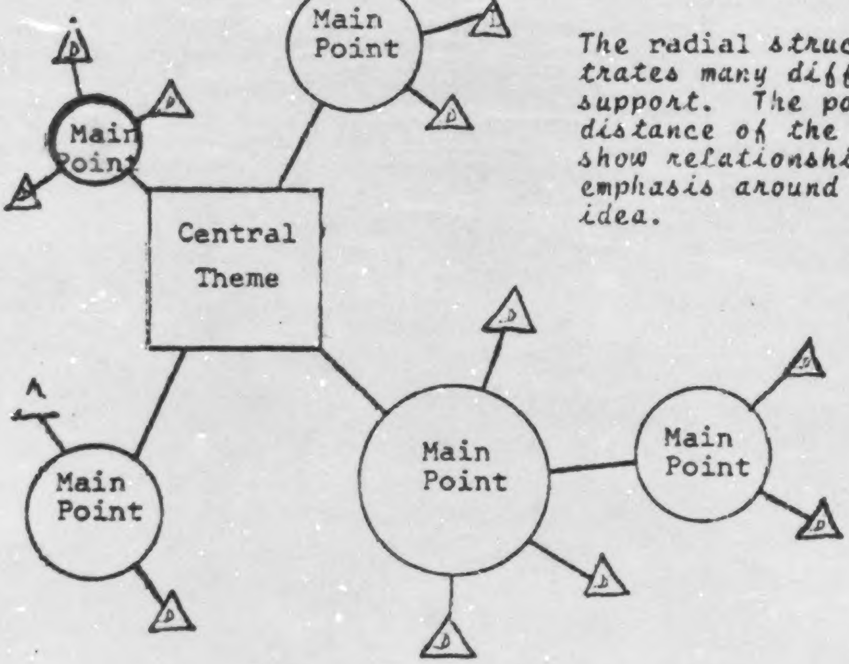
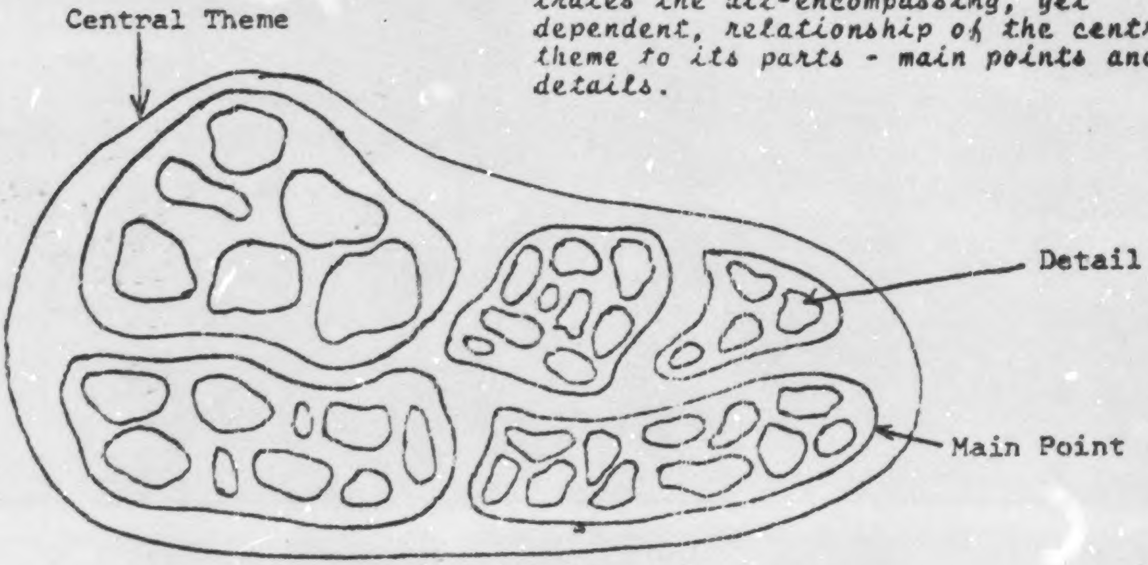
The radial structure diagram illustrates many different directions of support. The position, size, and distance of the structural parts show relationships of unequal emphasis around the nucleus of an idea.


Main Point
Main Point
Central Theme
Main Point
Main Point
Main Point
D
D
D
D
D
D
D
D
D
D
D

CELLULAR

The cellular structure diagram illustrates the all-encompassing, yet dependent, relationship of the central theme to its parts - main points and details.


Central Theme
Detail
Main Point

Step 6. Require the student to give a full statement of the principle.

Step 7. Verify the students learning of the principle.

To insure that the student is not giving a note definition, the student must demonstrate his knowledge by some sort of application of the principle.

Step 8. Provide for practice of the principle and for reinforcement of student responses.

Instructional conditions are not always optimal, and there is usually the practical necessity of providing for review and reinforcement beyond the original learning situation.

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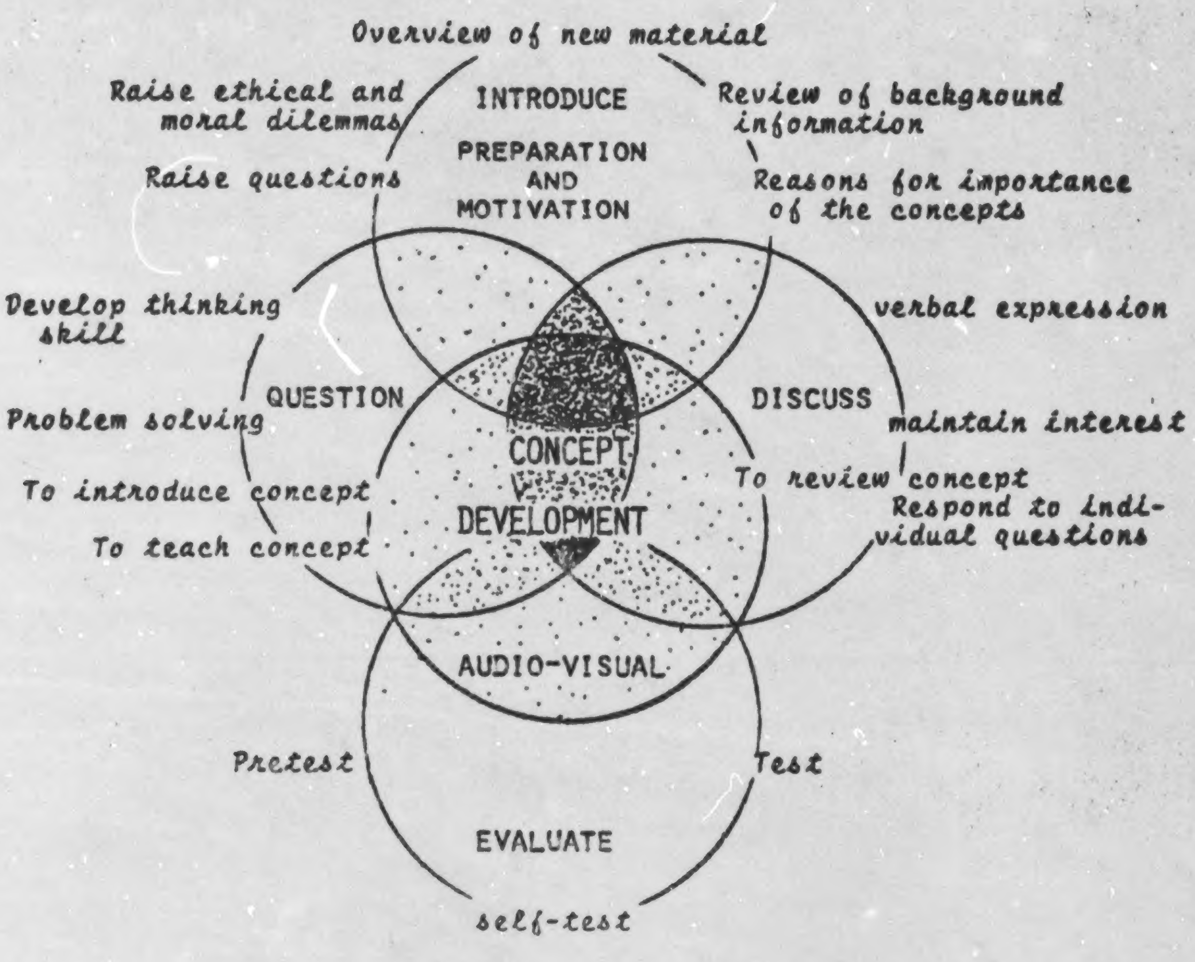
LESSONS


Overview of new material
Raise ethical and moral dilemmas
INTRODUCE
Review of background information
PREPARATION AND MOTIVATION
Raise questions
Reasons for importance of the concepts
Develop thinking skill
verbal expression
QUESTION
DISCUSS
Problem solving
maintain interest
CONCEPT DEVELOPMENT
To introduce concept
To review concept
Respond to individual questions
To teach concept
AUDIO-VISUAL
Pretest
Test
EVALUATE
self-test

Principles in Vocabulary Development

1. Since concepts and principles are named by words every lesson is a vocabulary lesson.

2. Vocabulary development occurs through the cognitive process. Vocabulary development is not a matter of memorization. Students need help in accomodating and assimilating the word and the concept it represents.

3. Vocabulary development occurs in stages and these stages should be kept in mind in developing lessons (Perception, Internalization, Contextual Perception, Perception of Differences, Conceptualization, Categorization).

4. Vocabulary development must be related to the students' level of intellectual development. Concrete objects are absolutely necessary for those students who are in the period of concrete operations. Those students who are capable of formal thought are able conceptualize categorize because of their ability to think abstractly. They are capable of learning principles.

5. Each new level of meaning requires more concrete experiences. (5)

6. The quality of meaning is influenced by the quality of background knowledge of previous experiences and previously acquired meanings and concepts.(5)

7. Common background experiences (through the use of concrete background experiences, visual aids, words in conversation and words in other contexts) enable students to understand many word before they read them.

8. Students should be presented with a meaningful framework from which they can visually see the interrelationships among the necessary vocabulary terms and concepts. (9)

9. Students need to be equipped with the skills necessary to learn vocabulary on their own.

Word Attack Skills

There are a variety of skills that students' can use when attempting to learn the meaning of a word on their own. Since teacher directed exercises in concept development are not available in this case, the meaning will always be approximate and indefinite. The student does need formal training in the use of these words attack skills.

Frederick and Palmer (6) describe 5 classes of skills: (1) Structural Analysis, (2) Context Clues, (3) Vocabulary Relationships, (4) Abbreviating symbols and acronyms, (5) Dictionary skills.

1. Structural Analysis: Knowing the structural elements of words will help students unlock many words containing those elements. Knowing the derivation of words and the meaning of the elements within words will help gain a more precise meaning. (4) In structural analysis attention must be directed to the following components of words:

   A. Compound words (6)
   B. Root Words (6)
   C. Prefixes and suffixes
   D. Inflectional endings (-Internal (mouse to mice)
      (-External (d, ed, ing, s, etc) (2)
   E. Pronunciation (13)

2. Context Clues: Often there are clues within the context of the sentence or paragraph that gives meaning to an unknown word. The classes of clues are:

   A. Experience:

   B. Definition: There are five ways in which a word may be defined:

      (1) by giving a synonym
      (2) by classifying it
      (3) by enumerating words to which it relates
      (4) by example
      (5) by operational definition: ie. what to do in order to experience or recognize the thing to which the word refers. (14)

   C. Comparison or contrast

   D. Summary

   E. Association

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F. Reflection of Mood or Situation

G. Previous Contact

H. Syntactic Context: by knowing the part of speech of the word, the learner limits the number of possible choices. (12)

I. Markers: used with syntactic context clues

(1) noun marker: the, a, an, a cordinal number, possessive
(2) phrase marker: prepositions
(3) verb marker: was, had, will, etc.
(4) clause marker: since, when, if, that, because (12)

J. Qualifying Words: words such as many, no, more, most, less, few, only, almost, always, all are very important in getting meaning of a sentence. (2)

K. Common Connectives: when, although, while, therefore, also, then, so, yet, perhaps, that is, such as serve as traffic signs in reading.

Go or Coordinating Signal: also, then
Caution : therefore
Turn : but, yet, although
Stop :
Relationship : when (12)

3. Vocabulary Relationships

A. Synonyms: different words with the same meaning.

B. Antonyms: words with contrasting meanings.

C. Homonyms: pronounced and spelled the same but with different meanings depending on context.

D. Homophones: pronounced the same but have different spelling and meaning.

E. Homographs: spelled the same but pronounced different and have different meanings. (6)

4. Abbreviations, Symbols, Acronyms

5. Dictionary Usage: includes skills in

A. Alphabetizing

B. Using Guide Words

C. Determine derivation of each word from dictionary

D. Use dictionary to note syllables that are accented

E. Divide words into syllables (13)

Guidelines for Teaching Vocabulary

Sherk and Manzo (14) and Frederick and Palmer (6) offer several useful guidelines for teaching vocabulary.

1. Vocabulary development requires the continued and systematic attention of all classroom teachers.
2. New words are learned best when taught as labels for direct experiences.
3. Initial examples should be easy.
4. Vocabulary teaching strategies which stress induction will tend to result in the best learning of rules governing words and word parts.
5. Study of Latin influences the knowledge of morphemes but not vocabulary.
6. Wide free reading does not develop vocabulary.
7. Almost any technique which draws attention to word parts and/or word meaning will positively influence word acquistion when compared with no attention.
8. Specific word attack skills should not be identified or labeled during their teaching.
9. Skill should not be presented in isolation without being related to subsequent skills.
10. It is possible, but not practical, to teach words which are not part of the verbal community in which the student lives.
11. The presentation of many new words and allusions in a gamelike incidental learning fashion can often provide a major source of stimulation for attention to, and growth of vocabulary.
12. Exercise formats should be varied.
13. At least five types of guidance are needed for vocabulary development: (a) context awareness, (b) dictionary awareness, (c) word awareness, (d) structural awareness
14. Learning paces should be monitored to insure maximum progress.
15. Newly acquired skills should be integrated with existing skills to promote growth in overall process.

16. Many encounters with a word in different contexts are needed.
17. The teacher's attitude toward vocabulary improvement and the superiority of his own vocabulary are contageous and vital factors in the improvement of student vocabulary.

Classroom Activities - Pre-reading exercises

When a teacher gives a reading assignment it must be done with definite purposes and goals in mind. The reading assignment should be guided toward those goals. The teacher must anticipate the needs of each student and offer help where required. The direction of such pre-reading exercises should be to:

1. introduce new words in context,
2. spotlight an easy root word along with a long forbidding word,
3. reduce difficult polysyllables to easy to manage syllables,
4. call attention to accented syllables,
5. preteach important concepts that are represented by words,
6. connect new ideas with old ones,
7. increase student response by asking questions designed to elicit meaning from students,
8. tap teen experience,
9. preteach multi-meaning terms,
10. help insure retention,
11. build on student's strengths and shove up weaknesses,
12. help students move toward independence, and (9 & 4)
13. Techniques need to be selected that are consistent with the types of key words being studied. Poeton suggests these three types of words:
    1. Hard concept - easy reading ex. induction
    2. Hard concept - easy concept ex. prognosis
    3. Hard concept - hard reading ex. photosynthesis (11)

These pre-reading exercises will be a topic of a future workshop.

Classroom Activities - Word Attack Skills

1. Use as many first hand experiences as possible. (13)

2. Use pictures, objects, dramatizations and A-V cards to give concrete illustrations. (13)

3. Discuss the concept that the word labels. (13)

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4. Alert students to context by working with them in making an intelligent guess about a word's meaning by the way it is used in a sentence. (3) The Cloze procedure can be used to diagnose and/or teach context clues. After the students have completed the Cloze exercise each student must identify the reasons for choosing a word. Those reasons can then be discussed. The Maze Technique is like the cloze procedure but instead of blanks, three choices are given. The words deleted in either of these adaptations do not have to be the 5th or 10th. Words deleted can be chosen to suit the purpose of the exercise. (7)

Connectives are an important context clue. Robinson (12) lists five(5) guidelines for handling connectives:

A. Time needs to be planned for working on frequent and complex connectives in each subject area. Direct and consistent instruction should be given.

B. Along with direct instruction, incidental aid must be administered on an individual basis, for students often differ in their abilities to handle more abstract connectives.

C. Instruction followed by wide reading permits youngsters to meet the connectives over and over again so that natural reinforcement takes place.

D. All instruction must be in context or else it is meaningless.

E. Instruction should be followed by opportunities to practice.

5. Provide a study of antonyms and synonyms. (13)

6. Study prefixes and how they alter a word.(13) Often meaning can be derived from a word by considering the smaller units of meaning within the word. (morpheme) These smaller untis of meaning include the root word, prefixes and suffixes, and inflectional endings. There are several exercises which can be implemented on the class to help students with this technique.

   A. Work from known morphemes in familiar word to those in the unknown word.

   B. Look for context clues.

   C. Emphasize the words by listing the key words with multiple choice definitions.

   D. Morphemes baseball. Choose a morpheme from a hat. A student reaches first if he can define the morphemes. Second base is awarded if he can also give a word using the morpheme. The student goes to third base if he can define that word or use it in a sentence and he goes home if he also gives another word using the morpheme.

   E. Morpheme Tree or Mobile.

   F. Morpheme Concentration. Lay out cards of roots, prefixes or suffixes. Turn over two cards and make a word, if possible. If the student can define the words he keeps the cards.

G. Morpheme Word: This exercise is played like Bingo. Students have cards with morphemes on it. Teacher reads definitions. To win the student who has winning combination must read the morphemes and their definitions.

H. Root and prefix assembly line.

I. Student booklet: This is prepared by the teacher. In the booklet are listed all of the roots and affixes used in the book. The following format would be used:

ROOT/AFFIX	MEANING	EXAMPLE	YOUR WORD
pseudo-	false	pseudopod	

To encourage frequent use
The booklet should be of a size to fit easily in the text, it should be memeographed, and it should be on colored paper.

J. A couple of Roots that Took: The word is given with its definition, the root is defined and its origin given. This is followed by several common words using the root and their definitions. Finally two(2) uncommon words using the root are given.

Example: Campaign: fought on a field
camp = field
Campus: field where college is located
Decamp: leave the field
Camp: live in the field
Scamp: a coward who runs from the field
Champion: the winner of the field
Champagne: wine from a region in France with rolling fields.

Synonyms Antonyms

Encourage wide reading as a means of providing the students with various instances of a word usage. Wide reading will increase vocabulary if the reader pays attention to words. The teacher must often direct this attention. (14)

Encourage interest in words through discussion of idiomatic phrases, figurative language and interesting word origins. (13) Interest in words can be stimulated by discussing the story or history behind a word. Two such techniques are "Who Dreamed up That Word?"(4) and "A Word with a Tale" (3)

Keep a notebook record of

a) new words students meet and learn
b) words related to special subjects
c) words related to hobbies
d) new uses and additional meanings of familiar words
e) substitutes for overworked words
f) words that describe or characterize particular persons, objects, or situations
g) words appealing to senses
h) idiomatic phrases

Substitute specific words for overworked words (13)

Replace slang with legitimate words (13)

Point out words that denote categories (13)

Devise vocabulary bees (13)

Discuss indefinite words such as few, many, any, large, small, litte much, some, several. (13)

Discuss definite words such as all, always, certain, every, sure, never, right, true, whole. (13)

Games with Words.

Encourage students to devise acronyms, palmdrome, blended words, malapropisms, oxymonons, rebus, spoonevisms. (13)

Buddy Vocabulary Cards: Students pair up for vocabulary study using card they have made up from their reading as follows:

3 X 5 Card

Word in context

word = phonetic spelling

Side 1

Word in context

word = phonetic spelling

meaning

Side 2

The students then dwell each other using the other persons cards. The features of such vocabulary training are: (1) learning takes place on both sides of the card by both buddies; (2) every student finds some words he doesn't know, even the smartest; (3) students help each other. (10)

Vocabulary Diagnosis

Thomas and Robinson (16) suggests 3 ways of diagnosing the students skills in vocabulary.

1. Standardized
    - A. Diagnostic Reading Tests; Section 1: Vocabulary
    - B. Michigan Vocabulary Profile Test
2. Informal Teacher Made Tests
3. Student self appraisals

> "What do you do when you're studying on assignment and meet an important new technical term?"

Biology and Vocabulary

Biology is a course with a high concept density and vocabulary. Concepts are dependant upon previously learned ones and are intertwined with other concepts to form principles. The principles are also interwoven with each other and form schemes. This makes concept maping essential so that the teacher can recognize the interrelationships before he begins teaching and can order and organize the various elements of the learning experience properly.

The vocabulary of a chapter names these principles and the component concepts. Very often the student will be able to get some meaning of the word by structural analysis. This meaning will be quite incomplete at this initial stage. Further meaning will be added in the text through definitions, examples, diagrams and pictures. Analogies and explanations in the form of models are useful classroom exercises to help students understand the concepts. Biology also contains many abbreviations and symbols to name objects and symbols.

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Project CAPABLE

CLASSROOM ACTION PROGRAM:

AIM: BASIC LEARNING EFFICIENCY

"to make each student a more capable learner"

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NOVEMBER-DECEMBER REPORT

DRA & SQ3R

TITLE IV: PART C
DEVELOPMENTAL GRANT

SCIENCE

Paul Germann

The goal of Project Capable is "to make each student a more capable learner." The ultimate goal is that each student become an independent learner and therby be equipped for a lifetime of learning. In the classroom we must work from learning that is dependent on teacher direction to that which is independent.

Traditionally, many content area teachers have used and still use a "sink or swim" approach. They view any special help from the teacher as only increasing the students dependence on them. The unhappy result is that many students are left to "sink" who might very well have learned to "swim."

As Hansell (4) points out, "students can be frustrated, irritated and demeaned by being required to attempt tasks at which they cannot succeed." The goal of instruction should be to help the student by removing as many barriers as possible and facilitating the path of learning for maximum efficiency. At the same time, the goal should be to make the learner independent and self-sufficient.

This paper will investigate an appropriate method which will help students learn from their environment. The major emphasis will be on learning from reading but we will also investigate the most useful and efficient methods of learning from listening and observing.

Review of the Cognitive Process

Central in our model of cognitive structure is the learner's store of information and concepts. It is with this background of knowledge that each new idea first must be brought into agreement, (accomodated), and then woven into the fabric of that knowledge (assimilated).

Our model suggests how this accomodation and assimilation takes place. First, the learner comes into contact with something new in his environment. This brings about mental disequilibrium as the learner attempts to accomodate and assimilate the new idea. This may occur quickly or it may take some time depending upon the complexity of the idea and how much it is in apparent agreement or disagreement with the learner's background of knowledge. The learner now trys various hypothesis that will bring about agreement with what he already knows. Each hypothesis must past several tests. If the new idea (1) is consistent with previous knowledge, (2) organizes the present data, and (3) leads to expectations in new situations that are consistent with the idea, it has been accomodated and is assimilated.

Review of Instructional Design

"Instruction consists of leading the learner through a sequence of statements and restatements of a problem or body of knowledge to increase the learner's ability to grasp, transform, and transfer what he's learning.(2) Instruction is involved in assisting students in making sense out of their environment. The goal is to reduce the complexity and uncertainty about the world they live in. The learner accomplishes this by (1) getting information through the senses, (2) processing information through their cognitive systems, and (3) storing the information for future recall and use.

In a previous paper I discussed several factors of instruction design which bear on student learning.

(1) Learning involves thought at concrete and formal levels of the cognitive process and occurs through accomodation and assimilation. As we now consider several methods of learning from our environment through reading, listening, and observing, they should be measured against these generalizations.

(2) Learning is built on previous knowledge. As already mentioned, it is central to the cognitive process. If the learner is faced with new knowledge that has no apparent familiar base in his background, learning is impossible or will be plagued with misunderstanding and misconception.

(3) The learner must be *motivated*. Central to motivation is that learner be conscious of the learning goals.

(4) The learner must pay *attention* to the learning task. This results from motivation.

(5) *Practice and repetition* are important in remembering information. It is during practice and repetition that various memory systems and cognitive states will process the information. Once properly assimilated the new knowledge is part of the learner's long term memory.

(6) *Feedback* is important to check for correctness leading to perfect mastery. This is a major portion of the cognitive pathways described earlier. The learner's mind needs time to work. He must reflect and during this time of reflection carefully question his conception of the new idea to see that it will hold up under scrutiny. Discussion and arguement with others is also another very important tool in the accomodation process. In such discussions the learner will have to use his background knowledge to support the new idea.

(7) *Reward and Punishment* is a form of feedback used by the learner to judge the corrections of his responses. Reward is administered for the act of learning while punishment is administered to learner, not the behavior performed. Bruner suggests that thinking and using information to solve problems and answer questions is in itself a reward for learning.

Instruction Through Reading - Dependent

Many strategies for teacher-directed learning through reading have been proposed. Each of these attempts to take into account all of the facets of good instruction to remove barriers and facilitate learning pathways for the student. There are as many such strategies as there are authors who write and readers who interpret those author's words. My reading has introduced me to the directed reading lesson (DRL), the directed reading activity (DRA), the directed reading-thinking activity (DRTA) and the instructional framework. All have basic similarities, yet each emphasize certain differences. This, of course, is all to the good. Each such technique must be flexible so that it can adapt to the styles of different teachers, the requirements of various lessons, the need for variety in the classroom, the individual differences of each student, and the unique character of each class. I am not going to attempt to give a summary of each of these techniques but rather provide a sythesis and interpretation that will produce a hybrid that seems to suit my purposes and needs. It is most similar to the Directed Reading-Thinking Activity (DRTA). This teacher-directed reading strategy is composed of four basic parts: I.) Preparation, II.) Reading, III.) Discussion and Comprehension Check, and IV.) Follow-up Activities. We will discuss each of these components in turn.

I. Preparation. This is the major component of DRTA. The learner is provided with just enough information to enable a student to read, think, and learn with success. There are six elements to preparation:

A. Orientation/Introduction
B. Motivation/Attention
C. Review Vocabulary/ Clarify Concepts
D. Background
E. Set purposes
F. Review Skills/ Direction/ Preview Reading Material

These elements are not necessarily sequential and certainly are not independent of other elements. They are interrelated, each playing an important part in the creation of a successful lesson.

A. Orientation/Introduction. The first introduction to a unit of study is very important. Students will be getting their 1st impression of what they will be studying and it is important that they look forward to it with interest and anticipation. The elements of motivation and attention will be anticipated at this time.

B. Motivation and Attention. Earlier in this paper it was noted that motivation and attention are important in any instructional design. The teacher must arouse interest and focus the students' attention on the problem at hand. Motivation is enhanced if they know what they are going to discover from the reading. Motivation will result when purposes are established which are related to what the students want to know and their concerns. Several techniques can be used for motivating and focusing attention. Among these are using non-printed material; a pertinent outstanding still picture, concrete object, or filmstrip; a heading with unusual significance; and excerpt to get interest; and questions posed by the teacher. Other factors to be considered in motivation are: (1) materials must be readily accessible; (2) the teacher's enthusiasm is contagious; (3) students should have time for wide reading; (4) materials at different levels are essential; (5) the style of the material is important; and (6) material must be pertinent.

C. Review Vocabulary/Clarify Concepts. Since learning is dependent upon the learner's background of knowledge, and instructional design must include the clarifying of concepts and review of vocabulary. The major and minor concepts that have important significance in the unit to be studied must be identified and special attention paid to them. This should not be done by itself but in conjunction with other elements of preparation.

D. Background. Background of knowledge is a central factor in being able to learn, as was discussed when cognitive structure and instructional design were taken up. There are two aspects to preparing a student's background of knowledge. The first is exploring the students' background to bring out what he already knows and what misconceptions he may have. Students often do not realize what they already know, wither because they do not remember easily, or because they do not see the relationship to the question being studied. In exploring the students' background, the teacher is attempting to provide a context into which new information can fit. In the second aspect of preparing the students' background of knowledge the teacher fills in the missing necessary background information. In this way a common experience is recalled, related to the unit, enlarged and strengthened. At the same time the teacher shows the students how the ideas they are to be studying are related to each other. When the background of knowledge is prepared in this way, the student will have a frme of reference, a framework for new ideas, intellectual hooks onto which new ideas can be hung.

E. Set Purposes. As a result of the preparation of his background of knowledge, the student begins to question and surmise the coming ideas. The teacher has provided the framework from which the student can anticipate and develop purposes. The reader will predict the likely purpose of reading guided by the questioning of the teacher. The teacher's role is to assist the student in raising questions that will set a purpose, and help him recognize his own errors, check his own assumptions and find his own answers. Other less desireable techniques of setting purposes is to use questions at the end of the chapter, teacher-posed questions, questions arising from behavioral objectives for the chapter, questions derived from headings during a survey of the chapter, or the teacher simply telling the students the purpose and what important ideas to look for. Depending upon circumstances, all of these techniques have their place.

F. Review Skills/Direction/Preview. The teacher reviews with the students the ideas to be discovered and the skills that will have to be applied. Special directions are given on how to apply the necessary skills. The reading material is previewed when necessary to note the basic structure of the information, discuss titles and subtitles, note graphic aids presented and to note study aids. (5,6,9,10,11,13,14)

II. Reading. The format of this component of the teacher-directed reading strategy depends upon the skill of the reader. Ideally this reading would be silent, independent reading guided only by the preparation that was provided. However, this, like any skill, requires practice and the active involvement in the learning process. The teacher should carefully guide the students reading and then slowly remove this guidance until independence is achieved. Two types of guides are suggested: reading guides and reasoning guides. The reading guide (1) gives structure to a conscious experience in applying skills and understanding context, (2) provides for individual differences in ability and achievement, and (3) ensures success in the assigned reading. The reasoning guide will assist the students' cognitive structure in assimilating and reacting to ideas in the reading by providing questions at various cognitive levels.

Both of these quides will encourage reflective behavior which is important in cognitive process and instructional design. It is important that the guide questions be ordered with respect to the cognitive process so that they lead to desired generalization. The guides also provide an informal assessment of the reader's skills. (5,7,9,10,11,14)

A postive attitude on the part of the reader is very important during the reading step. Studies have shown how attitude affects learning in five ways. First, attitude affects comprehension in that (a) negative attitudes promotes inaccurate interpretation and poor comprehension; (b) ideas similar to the learners are more easily learned; (c) ideas which are not similar to the reader's confuse and irritate; (d) the stronger the attitude, the more it infuences interpretation. Second, attitude influences recall. Ideas that the reader agrees with are recalled better than those with which he disagrees. Again, the strength of the attitude also influences recall. Third, rationalization increases to the degree that the reader disagrees and the strength of his attitude. Fourth, the stronger the negative attitude and the more the reader disagrees with the ideas presented, the less likely he is to read the selection. Fifth, the older the child the more his reading is kikely to be influenced by attitude.

These studies accentuate the importance of the preparation phase of the DRTA. (5,7,9,10,11,14)

III. Discussion and Comprehension Check. The reading is followed by an exchange of ideas and information between the teacher probes with such questions as "Were you right?," "What do you think now?," "How will you change your idea?," "What do you think will happen next?," "What would happen if...?," "Why do you think your idea is a good one?" The students support their ideas with data from the reading.

As a result of this discussion there will be a number of outcomes:

1. classify and guide the further development of concepts
2. review and clarify the basic structure of the information
3. assist students in recall
4. note need for further information
5. redefine purposes - set new purposes
6. develop skills

Referring back to the guidelines for instructional design this third phase of discussion and comprehension check should provide the reflective behavior, the practive and repetition, the feedback, and the positive reinforcement. (5,6,9,10,11,13,14)

The driving force in the reading and discussion and comprehension check is to guide and foster reflective thinking. Reflective thinking begins with a problem and moves toward a solution by sifting, relating and ordering a flow of ideas. To fo this the teacher (1) asks questions that will initiate, sustain and try to conclude an investigation into problems found in the reading selection; (2) ask questions that challenge unclear, factually incorrect, or contradicting statements; and (3) evaluate all responses according to his best judgment, selecting those to be answered immediately, tabling those to be perused later, and ignoring uninteresting, trivial or irrelevant responses.

All answers must be considered according to their merits. Any answer that answers the question asked must be accepted. There must not be a guessing game as to what correct answer is the teacher thinking of. In questioning there is no clear end except an answer that satisfies the understanding of the leader and participants.

Thinking means effort, activity and involvement on the part of the student. If is for this reason that the teacher needs to pay special attention to thinking. Thinking is a skill that needs to be taught and practiced. It doesn't happen just because the student has a brain. The quality of reflective thinking that will take place in the classroom will be a factor of the material and the teacher. The reading material should stimulate the imagination of the reader, lead in sequence toward a specific conclusion, and calls for a checking and listing of facts and arguements. The teacher must use the materials in a creative and provacative way and use skillful questioning.

The teacher uses two types of questions. Basic questions are always interpretive, have multiple implications, and lead to extended discussion. In order to guide and develop basic questions, follow-up questions are used. These are leading questions to analyze, develop implications, and resolve the basic question. (6,14)

IV. Follow-up Activities. The follow-up activity can be used to reinforce comprehension, and to extend understanding. Some possible followings activities are:

(a) Reread to

(1) clarify further important information

(2) provide specific skill training

-organize data
-interpret data
-evaluate

(3) apply information to real life situations

(4) formulate new ideas and reorganize old ones

(5) note use of words

(6) set up areas for further reading and research

(b) Conduct a Research problem using problem solving
    (1) delineate the problem
    (2) locate additional information
    (3) read
    (4) select and organize pertinent information
    (5) conclude and generalize
    (6) prepare and present a report

(c) Extend and clarify concepts

(d) Analyze information and relate to students lives

(e) develop and extend interests, attitudes and appreciations

(f) proceed to next chapter or unit

(g) special activity

(h) personal interest exploration

(i) cross content application

(j) purposeful oral expression

(k) recreational reading (5,14)

Hansell (4) provides a plan for devising a teacher-directed reading strategy. A teacher must:

1. Read the passage to identify important concepts.
2. (Mentally) outline the passage.
3. Decide how the passage is organized.
4. Design a key question which will illicit similar organization in the students' minds.
5. Test the key question to see if outline (step 2) answers the questions
6. Decide what initial information will help students guess about the content of the passage.
7. Search for ways others have applied these concepts.
8. Design open-ended questions that will encourage application.

9. Design an Introduction/Orientation for the students.
10. Develop a good motivating - attention focusing experience.
11. Determine what concepts will need development or clarification to prepare students background of knowledge for reading.
12. Determine what skills the students will need to successfully read the selection.
13. Purposes for reading.
14. Create a preparation lesson
15. Write reading guides and reasoning guides
16. Comprehension check
17. Follow-up

Among the benefits of the teacher-directed reading strategy are:

1. It closely reflects the way students learn through their cognitive processes.
2. It takes into account and responds to all of the factors of good instructional design.
3. It provides for an opportunity to respond to the uniqueness of each student through individualized instruction.
4. Excellent opportunities for individualization through grouping
5. Format has built-in for teaching learning skills integrated with content.
6. Allows for daily analysis of student skills and adjustments for ability.
7. Allows students to acquire concepts by manipulating the components to see how the concept is formed through guided experiences.
8. Provides a structure for a transfer from highly structured guided learning to independence.
9. Provide a structure for students to modify the pattern to suit their own needs and styles and true independence. (5)

Hansell (4) sums it up. "If understanding eases the reading task and if identification of meaning precedes word recognition, then all teachers may help students to read by helping them understand the content before they deal with print."

Instruction through Reading - Independent

Since the goal of instruction is to make students independent learners, students need to be taught a strategy for reading effectively on their own while slowly "weaning" them from teacher-directed reading.

Francis Robinson devised such a strategy for independent reading some thirty years ago. He called it SQ3R. His method has undergone many revisions and interpretation and is also known as SQ4R, SQ5R, PQ5R and PQRST. This demonstrates the flexibility and adaptability of his approach to a variety of instructional approaches.

The variation explained here will be SQ5R. SQ5R represents the seven steps: Survey, Question, Read, Record, Recite, Review, and Reflect.

Survey. The survey serves several purposes. It prepares the mind for what's coming. The reader gets some idea of what he is going to be reading about. Surveying will also define the nature of the problem, or, in terms of the cognitive process model, the disequilibrium. At the same time the reader will determine if the information to be presented will be new cognitive categories (n[illegible] concepts) or expansion of old ones.

The survey step consists of skimming through the selection examining the title, introduction, headings, pictures, charts, diagrams, summary, and review questions. If the teacher has provided behavioral objectives, these are compared to the selection during the survey. This step is the same process most readers use when reading magazines for leisure. They first flip through the magazine looking at titles, introductory, headings, bold-face excerpts, and pictures.

Surveying corresponds to certain parts of the preparation phase of the teacher-directed reading strategy. The reader is providing his own orientation and introduction to the selection, reviewing vocabulary and clarifying concepts on his own and preparing himself for setting purposes.

The teacher can provide practice for the survey step in many ways:

1. Ask students "How does the author help you learn what this chapter is all about in a few minutes?"
2. Model the "survey" in class.
3. Practice in class.
4. Have students "survey" and then "question" in class.
5. Ask students "Can you find the hidden outline?"
6. Ask students "How much can you learn in just ____ minutes?"
7. Practice on everything. (8,15,16)

Questioning. Questioning will provide specific purposes for reading and direction on how to read. In this step the reader examines the uncertainty, the mental disequilibrium, to describe what he doesn't know. These self-generated questions have been found to be more valuable than teacher-generated ones precisely for this reason. The reader is evaluating the reading selection in light of his own uncertainties. He will then read to find out the answers to his own questions and other important content.

The student performs this questioning step by turning the title, and headings into questions. He also looks at pictures, drawings and graphs to see if any questions are raised. As he skims through the text topic sentences and any bold-faced or italic print might stimulate some question. If the teacher has provided behavioral objectives, these also are turned into questions.

Again, this step often occurs during the recreational reading of a magazine. As the reader is skimming through the magazine prior to reading it, the titles, headings, bold-face excerpts, pictures, etc. bring questions to mind that he will answer later during the actual reading.

The teacher can help students practice the questioning step by:

1. Practice turning headings into questions during class.
2. Practicing "in depth" questions with the students.
3. Have students fill in a lable with two columns: "Headings" and

"Question."

4. Ask the students "What questions would your teacher ask on this?"

Research has shown that the best placement of questions for comprehension is either with all the questions before the selection or with each question just before the part of the selection in which it is answered.

Questioning corresponds to the "setting of purposes" during "preparation" in the teacher-directed reading strategy. (8,15,16)

Read. Reading is the main event of the procedure. The reader must be actively involved in reading to be successful. It is all too easy for the student to read the words but not be conscious of their meaning. The previous two steps have prepared him to be an active reader. He will now evaluate and select information that will fill the gaps in his own cognitive structure as reflected in the questions he has chosen. As the student reads, he relies on feedback from the environment and his own cognitive structure to guide him in selecting what information to attend to.

By "read" we don not mean that the student begins with the first word and proceeds directly through to the end. Reading is a "stop and go" process. The eyes shift back and forth from the text to pictures and drawings and back again. The eyes also shift back and forth within a section or paragraph as the reader attempts to extract meaning from the passage. There are frequent stops as the reader pauses to reflect. He asks himself "Does this make sense?", "How does this answer my question?", "What here is important, and what can be ignored for my purposes?" The reader skims, skips, or rereads to suit his purpose.

The reading step is practiced in class. The teacher does a model reading of a difficult passage. This can be done before the students read in the beginning, but as the students gain expertise, this modeling is most effectively done in a post-reading activity. The step should get practice during any teacher-directed reading strategy. (8.15,16)

Record. When the student has answered his question, extracted meaning from the passage, and has regained mental equilibrium, he writes down the important ideas. These answers to his pre-reading questions should brief, perhaps in a brief outline form. As the student records, he again reflects "does this make sense?" He rereads if necessary. This "record" step makes reading more active, provides an opportunity for the cognitive pathways to process the information, assists the long-term memory and provides material for review. (10,12,14,15)

Recite. When the passage is done, the reader stops and asks himself "What have I learned here?" He reflects and then recites, out loud, the important points. This procedure serves to check on clarity of ideas, encourages active reading, and fixes ideas in the memory. Research has shown that it takes at least five seconds per item to get information into the long-term memory. When the student recites, he slows down the imput of information. Together with the record step, a 4-power sensory learning technique is used. Four senses, eyes, mouth, ears and muscles, are used to learn as the student sees it, says it, heres it, and jots it down. (8,15,16)

Review. Most forgetting takes place shortly after the learning task has been completed. Immediate review will interfer with forgetting. To be most effective there should be one review immediately following the assignment, another within 24 hours, and this followed by periodic reviews.

The review can take many forms. The student might check the reading assignment heading by heading to see if he can recall the important information presented under each heading. A card can be used to cover the passage while exposing the heading. If the student has recorded his notes in outline form, he can look at main headings and then see if he can complete the outline, mentally, orally, or in writing. The student can try to recall the broad chapter plan and then fill in the details. No matter what technique is used, reflection is called for.

The student constantly challenges himself with "does this make sense?" (8,15,16)

Reflect. At any step, the student must reflect. He must stop and ask himself "Does this make sense?", "How does this relate?", "Do I understand?", "Can I give an example?", "What is the basic why of this?", "Can I make a generalization here?", "How does this fit into the world outside of class?", "How does this relate to previous knowledge?" If the reader can appropriately answer these questions, they go on. If not, he must reread. Reflection is taking time for critical thinking. This step is essential to learning and memory, because information can be accomodated and assimilated. (8,15,16)

Another Step? If I were to be so bold as to suggest another step it would be Reread. While this is already implied in SQ5R I make this addition to emphasize to students the need for more than just reading to successfully understand reading material. This becomes increasingly important as concept density increases, as in the sciences. Rereading serves many purposes. When needed, it is necessary for clarification. During rereading, new and specific purposes are set as the learner attempts to accomodate and assimilate some information. Rereading might be used in class or in small groups to extend understanding or apply a particular skill. (14)

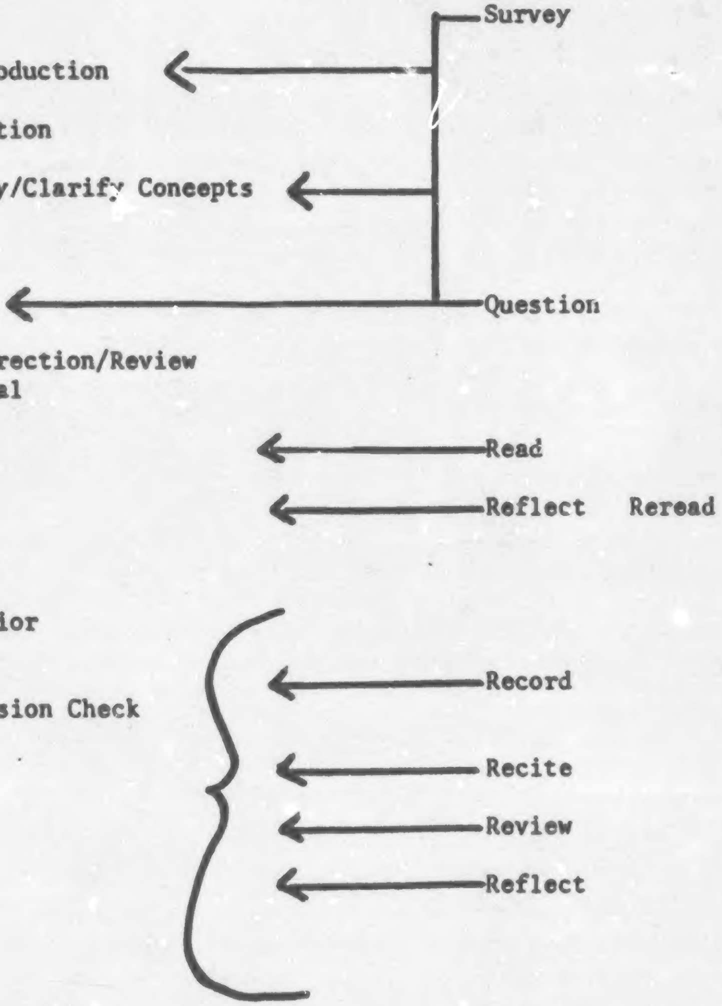
The steps of record, recite, review, reflect, and reread correspond to "discussion and comprehension check" in the teacher-directed learning strategy.

Transfer from Dependence to Independence

As much as possible, the teacher should attempt to make students independent learners. The high correspondence between the teacher-directed reading strategy and SQ6R, as suggested in the accompanying diagram, facilitates this. The teacher can direct, practice, and move students toward independence. He can individualize, giving special help to those who need it and provide independence for those who have acquired the skill.

Complete independence will be achieved by only a few, at least in biology. SQ6R does not provide for motivation/attention, background, or review of skills/direction/preview of reading materials. Perhaps the most difficult of these with respect to independence is background. Most students will need help in recalling or seeing the significance of information in their own background and how it applies to the problem at hand. Most high school students will need help in filling in necessary background information. None the less, our goal should be to make each student as capable and independent learner as possible.

1. Preparation
    - A. Orientation/Introduction
    - B. Motivation/Attention
    - C. Review Vocabulary/Clarify Concepts
    - D. Background
    - E. Set purposes
    - F. Review skills/Direction/Review Reading material
2. Reading
    - A. Reading guides
    - B. Reasoning guides
    - C. Reflective behavior
3. Discussion and Comprehension Check
4. Follow-up



Instruction through Listening and Observation

Little has been written concerning learning through the modes of listening and observation. The basic principles can still be described and applied and a general technique devised. The major difference and problem between listening and observation and reading is that information passes by just once and at a rate not controlled by the learner. Learning from listening and observation demands that the learner have an adequate background of knowledge. This background is perhaps more critical than in reading. When new information is met with adequate background accomodation and assimilation can occur at a rapid rate. New information that causes a great deal of mental disequilibrium is likely to be lost or badly misinterpreted.

Teachers often use the lecture or demonstration and for the reason must be aware of how this information will be processed by the student. Just as in reading, it would seem to be a waste of time to lecture or demonstrate without adequate preparation of the students background. In fact, the same format should be used here as for DRTA, that is, Preparation, Lecture and/or observation, Comprehension Check and Follow-up.

If the steps of preparation were cognitively sound for reading, they should also apply here. We should prepare students with A.) Orientation/Introduction, B.) Motivation/Attention, C.) Review Vocabulary/Clarify Concepts, D.) Background, E.) Review Skills/Direction/Preview of the lecture and/or observation.

Comprehension check should occur during the lecture and/or observation as well as afterwards. Learning must be active and the teacher must stimulate this mental activity. The teacher must be aware of pace. He must make sure the activity progresses at a rate that will allow time for thinking. His pace will vary depending upon the content and difficulty.

Being an independent learner by way of listening or observation depends on background. There is usually no way to prepare a weak background before such a learning experience unless one anticipates and develops it on his own, often by reading.

A Directed Reading - Thinking Activity

Biology

Behavioral Objectives

1. Explain the nature of cell division
2. Define mitosis
3. Name and describe the phases of mitosis
4. Label the following structures of the nitotic apparatus centrosome, centriole, centromere, aster, fiber, chromosome, spindle
5.
6. Explain the significance of mitosis

1. Read the passage

2. Outline the passage

Cell Growth and Reproduction

Growth of cells

- accumulation of additional materials results in growth
- there is a limit to the size of a cell

Limitations on cell size

- there is a critical relationship between volume and membrane
    - cell gets nutrients and gets rid of waste through membrane
- membrane does not increase proportional to volume
- cell division solves problem

The nature of cell division

-cell division called binary fission

-mother cell = cell ready to divide

-resulting cells = daughter cells

-mitosis - nuclear material duplicated and equally distributed to daughter cells

-cycloplasmic division - follows mitosis

Mitosis

-chromosomes: strands of DNA wound around protein core

-gene: DNA code for protein

-determiner of genetic trait

-before a cell divides DNA replicates -- 2 identical strands

-distribution of identical chromosomes to daughter nuclei

Interphase

-stage between nuclear divisions

-DNA duplicates

-centriole duplicates

-centrosome - small dense area of cytoplasm near nucleus

-centriole - small granuales in centrosome

Prophase

-centrioles move to opposite sides of nucleus

-aster forms

-chromosome shorten and thicken and become visible/chromated = each part of the double chromosome

-spindle forms

central fiber: extend pole to pole

traction fibers: extend pole to equator

-nuclear membrane dissolves

-nucleolus disappears

Metaphase

-pairs of chromatids (chromosomes) mass at the equator

-chromatids separate at centromere into identical chromosomes

-centromere attached to traction fiber

Anaphase

-chromoses migrate from equator to poles

Telophase

-reorganization of daughter nuclei and division of cytoplasm

  -chromosomes disappear

  -spindle and aster disappears

  -nuclear membrane reappears

  -cytoplasm divides into 2 equal portions
  cleavage furrow

Mitosis in plant cells

-plant cells lack centrosomes and centromeres = no aster

-instead of cleavage furrow - a division plate

Time and intervals of metotic divisions

-depends on environmental conditions - 30 minutes to several hours

-frequency varies plant or animal
type of tissue
circumstances

Significance of mitosis

mitosis preserves number as well as exact genetic makeup of chromosomes of all the cells of an organism.

3. Decide how passage is organized

A sequence of steps with events occuring during each step.

4. Design a key question which will illicit similar organization in the students' mind.

When a cell divides to become two cells each resulting cell has chromosomes which are identical to the original. How does this happen? What steps occur and what happens during each of these steps? Use the suits of a deck of cards to represent chromosomes which duplicate and then equally separate - how?

5. Test the key question to see if the outline (step 2) answers the question.

6. Describe what initial information will help students guess about the context of the passage!

The students know about DNA duplication.

Since the book does a poor job in describing the nitotic apparatus, show this on the blackboard. After seeing the mitotic apparatus they should be able to guess how the duplicate chromosomes will be equally distributed.

7. Search for way others have applied the concepts.

None

8. Design open-ended questions that will encourage application.

None

9. Describe how you will introduce this topic and orient the students.

You began life as a single cell. That cell had 46 chromosomes. (Where did these 46 chromosomes come from? (Review)) These 46 chromosomes contained the complete instructions for making you. (Do you remember how chromosomes can control the characteristics of an organism?) You are now composed of trillions of cells. Each of these has 46 chromosomes that are identical to those 46 you had when you were only one cell. KEY QUESTION (#4): How did this happen? What steps occur and what happens during each of these steps?

10. Develop a good motivation/attention focusing experience.

Show a time lapse movie of mitosis.

11. Determine what concepts will need development or clarification to prepare students background of knowledge for reading.

Review:

- chromosome
- gene
- DNA
- DNA duplication
- DNA control of the cell

New

- Spindle
  - -centrosome
  - -centriole
  - -aster
  - -fibers
  - -chromatid
  - -centromere
  - -chromosome

12. Determine what skill the students will need to successfully read the selection.

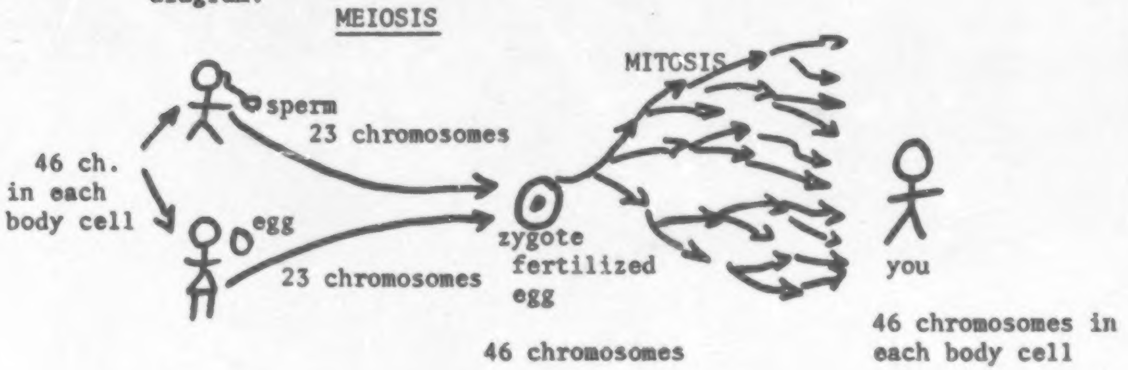
A sequence

13. Set purposes

1. Why can't a cell grow to unlimited size? Why is the "giant cell blob" in a horror film not possible?
2. How can a cell divide into 2 cells so that each cell has chromosomes identical to the first.
3. Why is it important that cells be able to divide in this way?

14. Create a preparation lesson

Begin with #9. Survey the chapter and then work around the following diagram.


MEIOSIS
46 ch.
in each
body cell
sperm
23 chromosomes
egg
23 chromosomes
zygote
fertilized
egg
46 chromosomes
MITOSIS
you
46 chromosomes in
each body cell

Produce this diagram on blackboard little by little using deck of cards - use hearts to represent chromosomes from the female and a black suit (spades) to represent chromosomes from male. Put two suits together to represent 26 chromosomes in zygote. The zygote will now divide into two cells, each with 26 chromosomes. Ask students "How can I demonstrate this with the cards." They should respond, "Each card will make a duplicate." Show this by adding 2 other suits. Now ask "How do I equally distribute these to two cells?" Students probably won't be able to answer. Tell students "This is our problem to investigate in this chapter. How do these duplicate chromosomes become equally distributed during mitosis?"

Ask "How is your text arranged to describe this process?" From their survey they should answer: "The book lists the phases as headings." Give directions on reading and notetake for a sequence of steps.

Now go over behavioral objectives. Ask students where they will find each using what they learned from the survey.

Since mitotic apparatus is poorly done in the text, do this now. When finished ask them to predict how the chromosome duplicates will be equally distributed.

15. Write reading guides and reasoning guides.

Limitations on Cell Size

p. 117 1. If the surface area of a sphere is $A = 4\ TTv^2$
and the volume of a sphere is $V = 4/3\ TTr^3$

what will be the difference in the rate of increase between the volume of a cell and its surface area?

The nature of cell division

p. 118 - paragraph 2.

2. What is the nature of cell division with respect to chromosomes?

Meiosis

p. 118 - paragraph 4.

3. Review: What is a chromosome? gene?

p. 118 - paragraph 5.

4. Review: How does a chromosome duplicate?

Interphase

p. 118 - paragraph 7.

5. Review: How does the nucleus control cell activities?

p. 119 - paragraph 1.

6. Review: How does DNA determine the structure of proteins that are formed in the cell?

p. 119 - paragraph 3-4.

7. What events occur during interphase to prepare for cell division?

8. How are these shown in figure 8-2?

Prophase

p. 119 - paragraphs 5-8.

9. List the events which will occur during prophase.

10. How does figure 8-2 represent these events?

Metaphase

p. 120 - paragraph 2.

11. List the events which will occur during metaphase.

12. How does figure 8-2 represent these events?

Anaphase

p. 120 - paragraph 3.

13. List the events which occur during anaphase.

14. How does figure 8-2 represent these events?

Telophase

p. 120 - paragraph 4-5.

15. List the events which occur during telophase.

16. How does figure 8-2 represent these events?

Mitosis in plant cells

p. 121 - paragraphs 1-3.

17. How is mitosis in plants different from mitosis in animal cells?

16. Comprehension Check

1. Why must a cell divide?

2. What events occur during interphase to prepare the cell for division?

3. What is interphase? What activities are occuring during this phase?

4. What events occur during prophase?

5. " " " " metaphase?

6. " " " " anaphase?

7. " " " " telophase?

8. What will happen in the daughter cells when mitosis is finished?

9. Compare the chromosomes of the mother cell and daughter cells. How are they the same and/or different?

17. Follow-up

Riffle Book

Lab: Mitosis in Allium Root Tip

Micro-Slide Viewer: Plant Mitosis
Animal Mitosis

Filmstrip: Mitosis
How Cells Divide

Cartoon movie

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Project CAPABLE

CLASSROOM ACTION PROGRAM:

AIM: BASIC LEARNING EFFICIENCY

"to make each student a more capable learner"

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JANUARY REPORT

STUDY SKILLS

TITLE IV: PART C
DEVELOPMENTAL GRANT

The Cognitive Process and Study Skills

The September Project Capable report on Comprehension presented a model as to how the cognitive process functions. This model was adapted from Piaget (3,5) and Lawson (7). Before discussing the relationship between study skills and the cognitive process, let's review this model.

A learner uses his senses to observe and explore his environment, usually by listening, reading, and observing. A new piece of information will present a problem to the learner and a state of disequilibrium will result. The learner may be able to accomodate and assimilate the new idea rather quickly or it may take some time.

The process of organizing the new information into the learner's store of knowledge by accomodation proceeds according to the following pattern. (see Figure 1) The learner engages in further observation and exploration. In this step he will be considering the concrete characteristics of the new idea. He then enters the phase of formal thought by forming a tentative solution or hypothesis.

During formal thought the hypothesis is evaluated with respect to three criteria: (1) Is the new idea or hypothesis consistent with the learner's previous knowledge? (2) Does the new idea organize the present data? and (3) Does the new idea lead to expectations consistent with new findings? If the new idea shows a good fit with respect to these criteria, it is accepted, assimilated into his store of concepts, and mental equilibrium is restored. If there is a poor fit, he needs to re-examine the whole phenomenon or mentally sort through other concepts for another idea to organize the phenomenon and solve the problem.

Study skills are tools for getting information from the environment (15). When a student has acquired study skills he has trained his senses to pick out relevant information from his environment. These skills facilitate organized exploration and will produce organized knowledge. The organization of knowledge through the study skills will greatly facilitate the formal thought processes. The study skills directly involve the formal thought pathways and decision making, thereby enhancing the student's ability in critical thinking.

Study skills, then, have a direct relationship to the cognitive process. If each student is to become a capable and efficient learner, we must see to it that he learns these skills.

The Study Skills

The study skills can be grouped in many different ways. This paper will discuss seven categories of study skills.

Once the student decides, for one reason or another that he wants to know more about a particular question or problem, he must obtain information. Obtaining information encompasses a number of subskills such as the use of table of contents, index, card catalog, Reader's Guide, almanacs, appendix, glossary, encyclopedias, bibliographies, the teacher, experts, films, etc. After the student has located some sources, he must use various rates of comprehension to get the information he wants. He will scan the information to see if the source has the information he needs; skim to determine the organization of the knowledge and then apply a variety of rates of study to get the information he needs.

Having found the information he wants, he will have to evaluate the source in taking the next step toward learning the answer to his question or problem. The student must determine the author's purpose and be able to recognize different kinds of paragraphs, main ideas and supporting detail.

Along with relevant information gleaned from written material, discussion, lecture, and observations will be data presented in Graphic Aids. Graphic aids, are maps graphs, charts, tables, diagrams, and cartoons, involving scales, lengends, symbols, and keys.

When the student has a good understanding of the information, he must be able to organize and summarize it. He must be able to evaluate the source's organization and then organize it himself in notetaking, outlining, summarizing, or concept mapping.

Superimposed over all of the previous steps is retaining what has been learned. Long term retention will be achieved when the information has been accomodated and assimilated so that it is integrated with the learner's store of knowledge. This is achieved by using some technique similar to SQ3R, which includes survey (skim and/or skan), question (set purposes), read (or listen and/or observe), recite, record, review, reread, and reflect. Notice that many of these steps are study skills already mentioned.

The last category of study skills, following directions is sometimes listed as a subskill of organization and summarizing. Following directions seems to be important enough and different enough in character to be considered as a skill by itself. (10, 15, 6)

Model for Teaching Study Skills

It is the aim of Project Capable "to make each student a more capable learner" by helping him develop effective learning skills. Our stated method is to use content to develop learning skills and then use those improved learning skills to learn content.

Shepherd (15) cites McKay concerning the proper place for teaching study skills. "Study skills in various content fields is preferred because the skills are taught and practiced where they are needed and in proper combination for the particular subject area, rather than in isolation. In addition, the actual materials of the course are used for the teaching and practice, so that students can see the usefulness of the skills." To those content area teachers who complain that they do not have time to teach study skills, Shepherd suggests that the teaching of these skills will not detract from or hinder the coverage of content. Instead, the learning of content should increase. Karlin (6) calls for a planned program of instruction to be used to teach study skills along with content rather that the usual hit-or-miss instruction. "It is not enough to require students to do a task; they must be shown how."

Reid (12) suggests a model he called the "functional-incidental approach." By this he means that proficiency with the relevant skills and the understanding of the concept are developed simultaneously. This requires an overall coordinated approach.

The actual teaching of the various study skills should occur in four stages. An introduction will prepare students for the skill to be developed. The teacher motivates the students, provides the rationale for the skill, and provides preliminary instruction. Following this the teacher directs some focused practice. The skill is then retaught before the students are given more guided practice to do independently. The study skills chosen should match the content so that the focused and independent practice can be centered around this content. (12) The additional practice should be guided practice during directed reading assignments until the student has mastered the skill.

Karlin (6) and Reid (12) make several suggestions for teaching study skills:

Lessons should

1. Cater to individual differences.
2. Provide for application and reinforcement of skills outside the program.
3. Provide some system of monitoring pupil achievement and growth at regular intervals.
4. Move students toward independence.
5. Use selections from materials for which the students are held responsible.
6. Select content material that presents no real meaning difficulties other than those on which practice is intended.
7. Teach only one study skill in a lesson.
8. Teach subskills in sequence, when a study skill consists of related smaller skills.
9. Teach a study skill when the need for it arises.

Check List of Study Skills

The following checklist was adopted from Karlin. (6)

I. Obtaining Information

Can the student

a. find information through the table of contents

b. locate information from the index

c. use the library card catalog

d. use the Reader's Guide

e. use an almanac

f. understand and use appendixes

- g. use glossaries
- h. use encyclopedias
- i. use bibliographies
- j. locate expert sources

II. Skim, Skan and Rates of Comprehension

Can the student

- a. scan to locate information quickly
- b. skim to get an overview of material
- c. choose an appropriate rate for good comprehension

III. Evaluate the Source

Can the student

- a. recognize different types of paragraphs
- b. recognize the significance of the content
- c. recognize important detail
- d. identify unrelated detail
- e. find the main idea of a paragraph
- f. find the main idea of longer selections
- g. locate topic sentences
- h. locate answers to specific sentences
- i. develop independent purposes for reading
- j. realize the author's purpose
- k. determine the accuracy and relevancy of information

IV. Graphic Aids

Can the student

- a. understand the significance of pictorial aids
- b. read and interpret graphs
- c. read and interpret tables
- d. read and interpret charts

Obtaining Information

Table of Contents. The table of contents is not only a list of topics in a book, but also reveals how the author has organized the topics. Student can be taught effective use of the table of contents by asking students to respond to a series of questions during focused and independent practice. More than one book should be used in a series of exercises until the student has mastered the skill.

The following qusstions might be asked about the table of contents from Modern Biology by Otto and Towle. (8)

1. What topics does the author cover in the book?
2. Into how many major sections is the first chapter divided? the second chapter?
3. Of what chaptes does the third unit consist?
4. What chapter is likely to contain information about how plants grow?
5. Why are some chapters much longer than others?
6. On what pages does the author discuss birds?
7. How likely is it that this book will contain information about drugs? about cancer?
8. Does this table of contents indicate if this book contains graphic aids? a glossary?

The Index. The index is a tool for finding information on specific topics quickly. The index may also give other useful information such as the location of maps, pictures, or definitions by using special type face for page numbers or special symbols. Students also need to be taught how to use the subentries of the index.

The following questions might be asked of biology students about the index of Modern Biology by Otto and Towle. (8)

1. In what order are entries listed? What other sources of information are listed in a similar way?

2. In what way are these two entries different?

   a. head, human

   b. hearing

   What is the natural order of the words in the first entry? Why is inverted order followed in the first entry but not the second? What does this mean about using an index?

3. In what way are these two entries different?

   a. Mammalia (italics)

   b. mammals

   What are some other terms that are written in italics like the first entry? What does printing a term in italics supposed to mean to you?

4. In what way are the names of persons listed?

5. On what page can I read about parental care in mammals? the theory of evolution by Jean Lamarck? fish ladders? deoryribose nucleic acid?

6. Look up the entry for coleus. Why is one of the page numbers in bold face print?

7. How are sub-entries organized?

8. How is this entry different from others? inheritance, see also heredity

9. How is this entry different from others? Why? artery(ies)

10. Why do commas separate page listings in some entries and dashes in others?

Card Catalog. Locating information involves several library skills, such as using the card catalog. According to model suggested earlier, the teacher begins by introducing the card catalog and its 3 types of cards (author, title, and subject) to the students and then provides focused practice. After reteaching the skill the teacher provides independent practice. All four phases of the learning process should be centered around these purpose setting questions.

1. Why is there a separate subject, title, and author card?
2. Why is the topic of a subject card placed across the top of the card?
3. What purpose do the numbers and letters in the upper left hand corner serve?
4. What common information do each of the three different cards contain?

Other Aids for Locating Information. The teacher needs to devise similar exercises for using the Reader's Guide, almanacs, appendix, glossary, encyclopedias, bibliographies, teacher, experts, films, etc. It cannot be assumed that the students are familiar with these sources. The teacher must show them and provide opportunities for practice.

Putting It All Together-Research Project. The research project is an ideal exercise for reinforcing skills in locating information. The students use a variety of references to find information and use the skills of location, selection and evaluation of reference material. Shepherd (15) lists the following skills that will be used:

a. comprehension
b. notetaking
c. ability to use the alphabet
d. ability to locate materials using Dewey Decimal classification or Library of Congress System
e. ability to use the card catalog
f. ability to use indexes such as Reader's Guide
g. ability to use specific reference material
h. ability to use guide words
i. ability to determine the best source of information
j. ability to differentiate between factual and fictional sources
k. ability to list a resource properly in a research paper
l. ability to skim

The steps for implementing such a project would be:

1. Select a topic
2. Discuss resource material-type and how to use
3. Develop a working bibliography
4. Teach and review technique of notetaking - especially the use of index cards.

5. Guide students in techniques of organizing information into a report.
6. The preparation of a report.
7. Discuss ways of presenting information to a class.

BIOLOGY RESEARCH PAPER

OBJECTIVES:

1. To use an interdisciplinary approach.
2. To introduce the mechanics or research.
3. To familiarize the student with different reference sources.
4. To allow the individual differences in abilities and interests.
5. To stress the importance to the scientist of the ability to write.
6. To create a procedure for expressing ideas soundly, logically, and clearly.
7. To develop the technique of problem solving.
8. To inspire students to investigate other areas of interest.
9. To provide an opportunity for teachers and students to learn from each other.

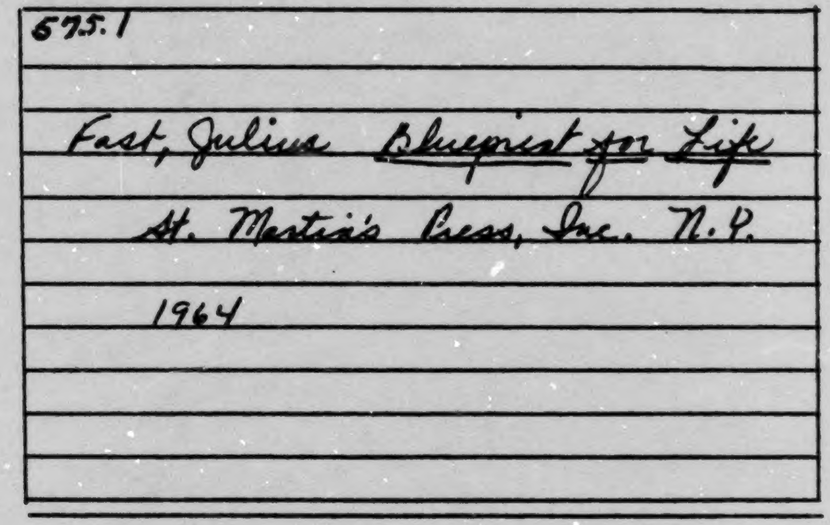
from:

Warner, Deborah, 1979. "Research on Topics With Unknown Answers." The American Biology Teacher, 41(1): 48.

BIOLOGY RESEARCH PAPER

WORKING BIBLIOGRAPHY:

List of 30 - 50 possible sources. Each reference, recorded in ink on a 3 X 5 card, includes the following items; author's name, title of reference, facts of publication, name of publisher, and date of publication; and any comments. Write the library classification number in the upper left-hand corner of the card and include a code for the library from which the reference came. References may include encyclopedia, magazines, journals, newspapers, and interviews. Guidelines for these references will be given by your teacher.



575.1

Fast, Julius *Blueprint for Life*

St. Martin's Press, Inc. N.Y.

1964

NOTECARDS:

Use a larger size card to avoid confusion. Avoid ususual abbreviations. Write on one side of the card. Place only one idea on each card. If you need a second card write "continued" at the top of the card and lable "A" and "B". Notes may include quotations, paraphrased summary of the reference, or personal comment. At the top of each card, indicate the dind of note.

The OUTLINE:

An outline enumerates important ideas to be developed in the paper. There is a relationship between the outline and the notecards. Avoid too many main headings but have at least three. If you list a I, you must also have a II. If you list an A, you must also have a B. This is true for all subdivisions. All main headings such as I, II, and III shoudl be of the same value. Align all headings with indentations for all subheadings. Although a topic outline is easier to prepare, a sentence outline is preferred because it helps you think through your subject.

WRITING THE PAPER:

Do not delay writing until the last possible moment. Allow time to write several drafts before putting the paper in its final form. Organize and use your notes, but do not copy them. Avoid colloquialisms and slang expressions. Use simple terms rather than technical ones when possible. Try to avoid personal references such as I, me, and mine. Have a dictionary and a thesaurus handy and consult them. Use your notes and outline to write the first draft. Use wide margins, skip a line between each line, write on only one side of each sheet. DRAFTS MUST BE IN INK AND HANDWRITEEN BY YOU. Be sure every paragraph has a topic sentence and vary the length of paragraphs to make you paper interesting. Write a short, concise summary paragraph that answers the question posed in the beginning of your paper. Keep any tables, charts, or diagrams brief and simple. Number each table consecutively throughout the paper.

FINAL COPY OF THE MANUSCRIPT:

The title page should include the title of the paper, the name of the student writer, and in the lower right corner, the title of the course and the date. In its final form, the paper should be neatly typewritten or printed on one side of 8½ X 11 paper. Retype or reprint any pages with more than three errors. All errors must be corrected. Allow margins of one and one-half inch at the left and top of each sheet and one inch at the right and the bottom of each sheet. Double space all text, but single space quotations longer than three or four lines and in the bibliography. Number each page. including the bibliography, in Arabic numerals (without a period) in the upper right hand corner. Page 1 is not numbered; numbering begins with page 2. Retain a carbon copy for your files. The paper you pass in will not be returned to you. The finished paper should include a title page, text, footnotes, and bibliography, in that order.

REFERENCES:

The final paper should have at least ten entries, with no more than two general encyclopedias and one science encyclopedia. Double space between each entry and if the entry requires more than one line, ident all lines after the first. Include only references you actually use. Arrange your references in alphabetical order by the author's last name, or if anonymous, by the first important word of the title. Publications issued by governments, institutions, or corporations are cited under the name of the issuing organization. If two or more items are by the same author, substitute a series of seven dashes followed by a comma (-------,) for the author's name in the second and subsequent items.

Rates of Comprehension

After the student has located a source, he must obtain from it the information he needs. This will involve scanning, skimming and using a variety of reading rates. Scanning is very fast reading to locate an answer to a specific question. Scanning involves (1) determing what specific fact is desired, (2) looking down the page for key words or figures, and (3) reading carefully as soon as the key word is spotted to determine if desired information is included.

Skimming is rapid reading to find out what something is about, to get an overview, or to get the general idea of a situation. Effective scanning uses introductory paragraphs, topical headings, first or last sentences of major paragraphs, italicized words, graphic aids, and summaries.

Schachter (14) suggests that phone books, local newspapers, and the table of contents from books can be used to teach skimming and scanning. Directed activities using content area texts can be given. The teacher gives the students a question (specific or general) to answer by skimming or scanning.

After skimming and/or scanning, the student uses a slower rate of reading to maximize comprehension. The appropriate rate will be determined by the difficulty of the material, the experience background with the topic, and the purpose for reading. (15)

Evaluate the Source

Evaluating the source calls upon several skills, such as determining the authors purpose, recognizing different kinds of paragraphs, finding the main idea, and identifying supporting data.

The basic unit for presenting a thought in written material is the paragraph. The student can use important guideposts to meaning if he can identify the function of a paragraph. The several types of paragraphs are (1) explanatory, (2) definitional, (3) introductory, (4) summarizing and concluding,

(5) transitional, (6) narrative, and (7) descriptive.

Explanatory Paragraph. Explanatory paragraphs perform the following functions:

a. present steps in a process or sequence
b. state a chronology of events
c. give instruction for performance
d. present and relate cause and effect
e. cite problems and solutions
f. raise questions and give answers
g. state a group of details relating to a previous paragraph
h. develop generalizations

These paragraphs are often coordinated with graphic aids such as graphs, charts, tables, diagrams, and pictures.

The teaching strategy should follow the model proposed earlier of (1) introduction, (2) focused practice, (3) reteach, and (4) independent practice. The teacher should caution the students not to skip unknown words. They should look for the meaning in the paragraph and, if this fails, to consult authoritative source, such as a dictionary, index, or even the teacher. Students should be aware that a full idea is rarely explained in one paragraph. Each paragraph must be seen as one in series that form a unit. Another point that students need to know is that graphics are often an integral part of an explanatory paragraph. The reader must refer back and forth. (13)

Example I - Explanatory paragraph - page 84 - Modern Biology by Otto and Towle (8). Here are some questions that can be asked during focused and guided practice.

Look at the 2nd paragraph on this page (on metaphase).

1. What kind of paragraph is this? What function does it serve? How do you know?
2. What is the relationship between this paragraph and others on the page?

3. Are there any graphic related to this paragraph? Which one(s)?
4. Are there any new words presented in this paragraph? What are they? How do you find out their meaning?

Definitional Paragraphs. A definitional paragraph focuses on clarifying the meaning of one or more words. Several paragraphs often form a definitional unit.

The teaching strategy for this kind of paragraph is to have students ask themselves, "what word is being defined?" and "What does it mean?" Students should be aware that most textbooks provide typographical aids and use verbal and/or graphic illustrations to help interpret definitions.

Example 2 - Definitional Paragraph - page 86 - Modern Biology by Otto & Towle (8)

Look at the second paragraph on this page.

1. What kind of paragraph is this? How do you know?
2. How is this paragraph related to others on the page?
3. Are there any typographical aids in this paragraph?
4. Are ther any graphic aids on this page that are related to the paragraph?

Introductory Paragraph. Introductory paragraphs provide focus and direction for reading. The reader should be on the look out for these paragraphs prior to study.

The students should be taught to look for certain clues to introductory paragraphs, such as "this chapter describes," "in beginning our study," "we are also presenting," "here we will study," or "lets examine." These paragraphs are used to set purposes, to speculate, or to hypothesize.

Example 3: Introductory Paragraph - Page 88 - Modern Biology by Otto & Towle.

Look at the fifth paragraph on this page.

1. What kind of paragraph is this? How do you know?
2. What clues are given in this paragraph?
3. What function does this paragraph serve?

Summarize and Conclusion Paragraphs. These paragraphs are most often at the end of a chapter or section. They serve as preview aids, comprehension checks, and review.

Students should be taught (1) to look for these paragraphs when surveying and setting purposes, (2) that the writer will let you know what is important in these paragraphs, (3) to match comprehension point for point when using these paragraphs for comprehension check or review, and (4) that several re-readings may be necessary if the reader is uncertain of the information in the paragraph or why conclusions was drawn.

A good teaching strategy, in addition to focused and guided practice, is to give a quiz based upon the summary paragraph.

Example 4: Summary and Conclusion Paragraph - Page 89 - Modern Biology by Otto and Towle (8).

Look at paragraphs four and five on this page.

1. How does the information in this summary match what has been presented in the chapter? Do this point for point.

Transitional Paragraphs. Transitional paragraphs serve to conclude one idea and begin another. They alert the reader to review what has been read and to get ready for a new idea. The paragraph will often use questions to do this. They notify the reader that this can be a temporary stopping place.

Instruction on transitional paragraphs should include impressing upon the students the importance of questions in these paragraphs. Students tend to skip such questions to get to answers. Readers also need to be encouraged to stop and take stock. They should review if necessary and begin to anticipate what is coming next. Many students need to understand that Run in headings, which are often in a transitional paragraph, are not part of the paragraph. (13)

Example 5: Transitional paragraph - page 91 - Modern Biology by Otto & Towle.

Look at the fourth paragraph on this page.

1. What kind of paragraph is this? How do you know?
2. How is this paragraph related to other paragraphs on the page?
3. What ideas are suggested for review?
4. What information is provided about the new information to be read?

Descriptive paragraph. A descriptive paragraph attempts to "paint a picture" and at the same time explain. In exercises for these paragraphs, students should be able to outline such a paragraph for information and draw a picture based upon the description. If a graphic aid is already provided, the students need to work back and forth between paragraph to graphic.

Example 6: Descriptive Paragraph - page 92 - Modern Biology by Otto & Towle.

Look at paragraph three on this page.

1. What kind of paragraph is this? How do you know?
2. How is this paragraph related to other paragraphs on the page?
3. What is the main idea? supporting data? Make an outline to show these ideas.
4. How is this paragraph related to any graphics on the page?

Main Idea. Essential to obtaining information from paragraphs and understanding how the information is orgainized is locating the main idea. Putnam (11) suggests a three step procedure for teaching and providing practice for main idea. Step one is a class oral exercise in which a paragraph is discussed: For step two, students choose the best from a selection of three possible topic sentences. The third step is to provide a topic sentence from some previously read material and the students write some detail sentences to support the topic sentence.

Putnam suggests that these exercises be provided for four levels of paragraphs.

Level one: topic sentence appears at the beginning of the paragraph with obvious supporting detail.

Level two: topic sentence appears at the end of a paragraph.

Level three: topic sentence appears in a place other thean the beginning or end.

Level four: a paragraph with no topic sentence. The main idea is implied.

Example 7: Main Idea: Level one - page 94- Modern Biology by Otto & Towle.

Look at the first complete paragraph on this page.

Step One exercise: Discuss this paragraph in class. Show how the first sentence is the topic sentence. Discuss which of the following sentences are relevant and which are not.

Step two exercise: Choose the topic sentence from the following choices.

a. A gene sometimes mutates several times in a row.

b. Some mutations occur more often than others.

c. It is hard to determine the rate at which some genes mutate....

Step three exercise: Complete a paragraph using the following topic sentence.

"Mutations occur at different rates."

Example 8: Main Idea - Level Two - page 96 - Modern Biology by Otto & Towle.

Look at the fifth paragraph on this page.

Step one exercise: Discuss this paragraph in class. Show how the last sentence is the topic sentence. Discuss which sentences are relevant supporting data and which ones are not. Discuss the relationship of the sentence in bold face type to the paragraph.

Step two exercise: Choose the topic sentence from the following choices:

a. In either case, a gentic trait is changed by the environment

b. Temperature differences may affect the gene action or enzyme action.

c. Normally this rabbit is white except for black nose, ears, tail and feet.

Step three exercise: Complete a paragraph using the following topic sentence.

"The environment has an affect on a genetic trait."

Putnam (11) makes several other suggestions for teaching main idea.

1. Choose which of three sentences best summarizes the main idea of this paragraph.
2. Write headlines for paragraph.
3. Number the sentences in a paragraph and discuss the relationships to each other.
4. Present the student with a paragraph which has a sentence that doesn't belong. The students identify the wrong sentence and the topic sentence.
5. Present a scrambled paragraph and ask students to put it into logical order.

Several other paragraph skills need to be developed besides these. Paragraphs are small units of larger units. These larger units also have a main idea and supporting data. The learning strategy is the same format as for paragraphs.

Another skill students need is recognizing irrelevant material. Karlin (6) suggests having students identify irrelevant ideas in a paragraph, matching headlines with short articles, providing headlines for short articles, and determine the purpose of an experiment from its details.

Graphic Aids

Graphic aids include maps, diagrams, charts, tables, graphs, pictures, cartoons, and time lines. Most of these are used in biology. These aids help in the understanding of expository information. They make the information more concrete. A picture is worth a 1000 words.

There are several mechanical aspects of graphic aids that students need practice with. These have to do with the clear presentation of the information such as the title, caption, values that are represented, proper labeling, and the meaning of various symbols presented in a key, legend or scale.

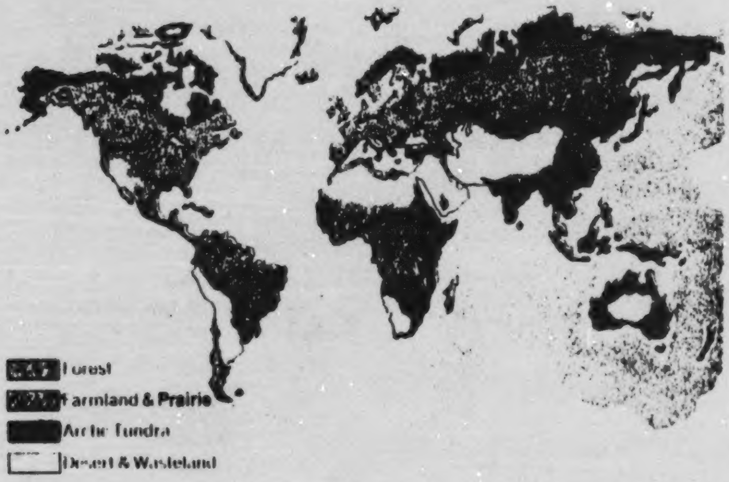
There are two major skill abilities in getting information from graphic aids. First is to understand what is stated, and second, to understand what is implied. The second of these skills refers to making inferences, generalizations, and conclusions. This depends upon the students' experiential background and their ability to apply this background to the graphic.

Shepherd (15) suggests that students often do not use graphic aids because little use is fostered in the classroom, some teachers consider aids are needed only by beginning readers, or their use seems so obvious that the teacher thinks that anyone can interpret them.

Biology provides excellent opportunities for teaching graphic aids. During laboratory exercises students gather data and information that should be described in a graphic way. There is no better way to teach the meaning of tables, charts and graphs than by teaching the students to create and develop them themselves.

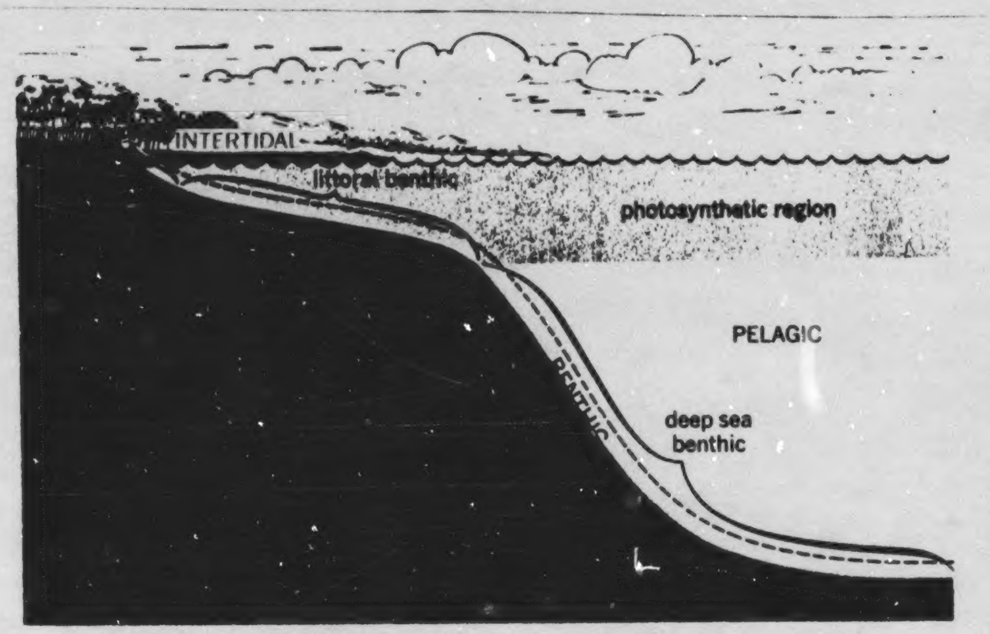
Maps. Maps appear in biology texts, expecially in environmental studies. Particularly useful are contour maps, relief maps, vegetable maps, and cross sectional maps.

Example 9: Maps - Modern Biology by Otto and Towle (8).


Forest
Farmland & Prairie
Arctic Tundra
Desert & Wasteland

51-1 This map of the world shows the distribution of vegetation and use of the land

1. Where are the deserts of the world located?
2. Where are the farmlands and prairies of North America located?
3. In what part of the globe do we find the tundra?


INTERTIDAL
littoral benthic
photosynthetic region
PELAGIC
BENTHIC
deep sea benthic

Example 10: Maps - Modern Biology by Otto & Towle (8).

1. In what other way might you describe the benthic region?

2. What is the relationship between the littoral benthic and the photosynthetic region?

3. What must be the difference between the photosynthetic and Pelagic region?

4. What do you think causes the difference between the photosynthetic and Pelogic regions? the littoral benthic and benthic?

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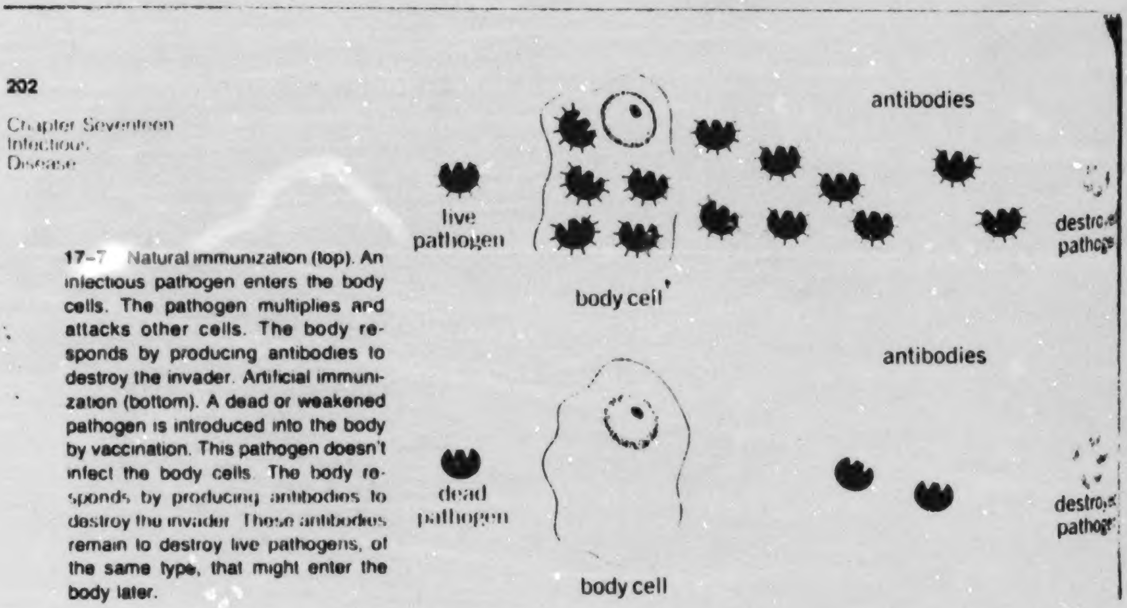
Diagrams, Charts, and Timelines. These graphic aids are used often in biology to show sequence, organization, process, comparison, development, or flow of types of information.

Example 11: Diagram below - Modern Biology by Otto & Towle (8)



202

Chapter Seventeen
Infectious
Disease

17–7 Natural immunization (top). An infectious pathogen enters the body cells. The pathogen multiplies and attacks other cells. The body responds by producing antibodies to destroy the invader. Artificial immunization (bottom). A dead or weakened pathogen is introduced into the body by vaccination. This pathogen doesn't infect the body cells. The body responds by producing antibodies to destroy the invader. These antibodies remain to destroy live pathogens, of the same type, that might enter the body later.

1. In the top series of drawings, what does the pathogen do in the body cell?
2. What does the body do in response to the attack by a pathogen?
3. How is the lower series of drawings different from the top? Why is the result the same?

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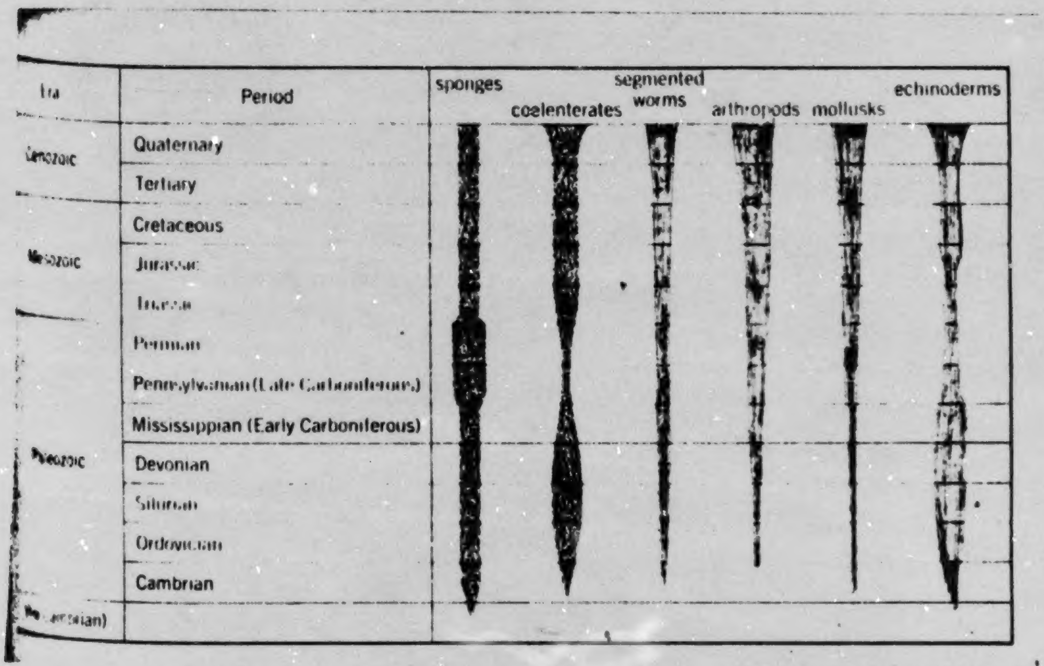
Example 12: Time Table - Diagram below - Modern Biology by Otto & Towle (8)



28-2 A time scale comparing the sponges and coelenterates to the other invertebrates.

1. Which group of organism is not increasing in size at the present time?

2. During which periods were sponges at their most abundant?

3. During which periods was there a decrease in the numbers of coelenterates?

4. Do we have any evidence that something dramatic must have happened during the Mississippian and Pennsylvanian periods?

When interpreting charts, students should ask themselves, "What type of chart is this?" "How is the information presented?" and "What symbols are being used?"

Tables. Tables are used often in biology to present statistical information and data.

Example 13: Table - diagram below - Modern Biology by Otto & Towle (8)

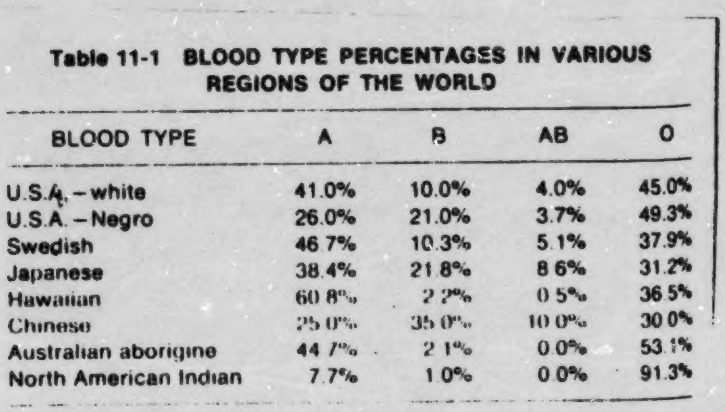


Table 11-1 BLOOD TYPE PERCENTAGES IN VARIOUS REGIONS OF THE WORLD

BLOOD TYPE	A	B	AB	O
U.S.A. – white	41.0%	10.0%	4.0%	45.0%
U.S.A. – Negro	26.0%	21.0%	3.7%	49.3%
Swedish	46.7%	10.3%	5.1%	37.9%
Japanese	38.4%	21.8%	8.6%	31.2%
Hawaiian	60.8%	2.2%	0.5%	36.5%
Chinese	25.0%	35.0%	10.0%	30.0%
Australian aborigine	44.7%	2.1%	0.0%	53.1%
North American Indian	7.7%	1.0%	0.0%	91.3%

1. What percentage of people in Japan have type O blood?
2. What is the rarest blood type in any nationality group?
3. What is the difference in the number of people with blood type O - between whites and negros in the United States?
4. In what way are the North American Indians different from all other national groups?

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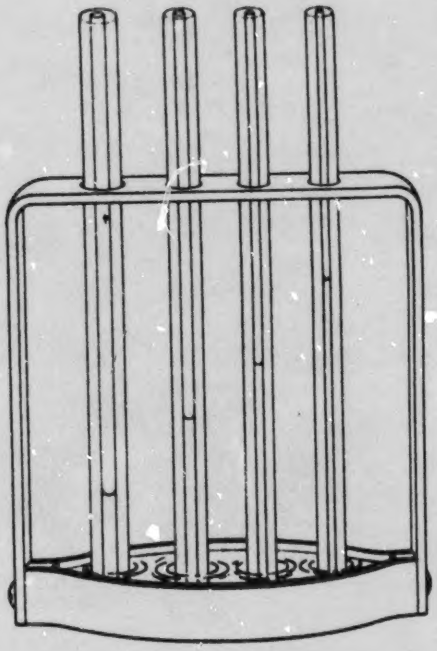
__Graphs__. Graphs are used to present tabular information in a more visual and dramatic way. They are excellent in showing growth or decline or the size of relative parts. Graphs can take the form of line or profile, bar, circle or pie, and picto graphs.

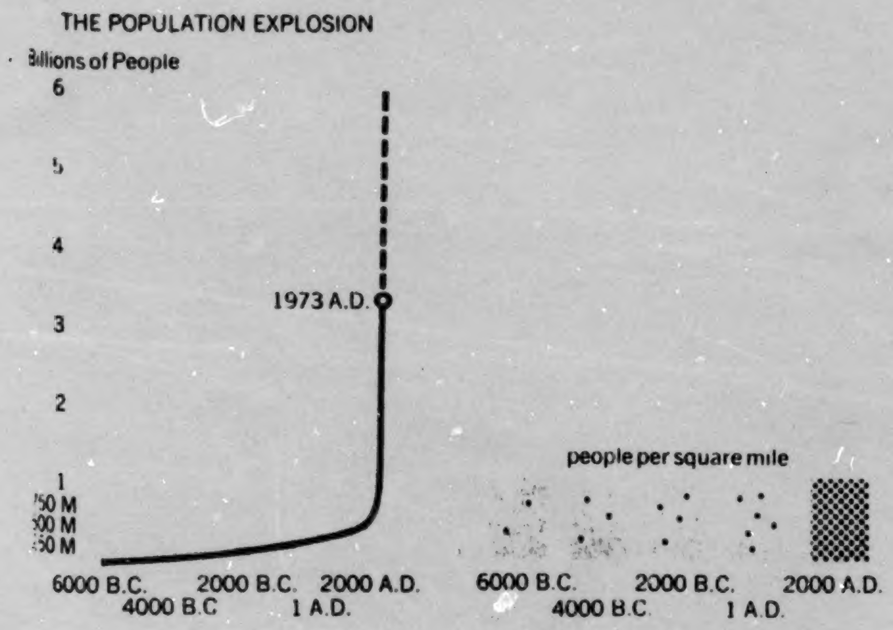
Example 14: Picto graph - diagram below - __Modern__ __Biology__ by Otto & Towle (8)

25-5 Demonstrating capillarity. Each of the tubes has a bore of a different size. Explain the difference in heights of the liquids in the tubes.



1. From left to right, what is the difference in the glass tubes?
2. From left to right, how is the water level different?
3. What is the relationship between the size of tube opening and the height?

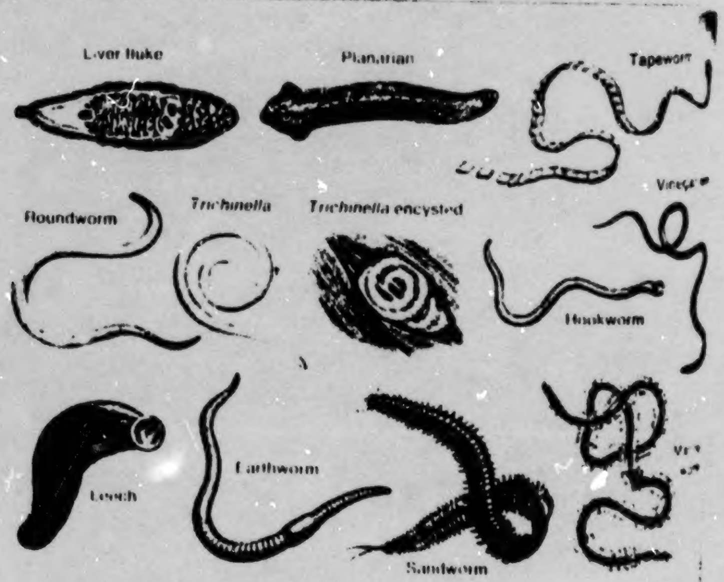
Example 15: Graphs - diagram below - Modern Biology by Otto & Towle (8)



1. How many people were on earth in the year 2000 B.C.?
2. How many people per square mile in the year 2000 B.C.?
3. How many people are on earth today?
4. About what year were there one billion people?

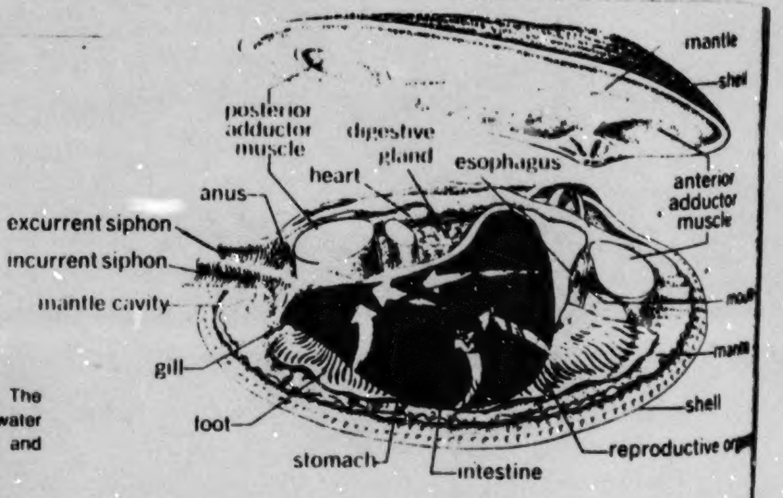
In understanding graphs students must consider the type of graph, the kind of data presented, the unit of measurement, the arrangement of data, numerical guides of horizontal or vertical bias, and the significance of the information.

Pictures: Pictures supplement information presented in the text. They add interest and motivation.


Liver fluke
Planarian
Tapewor
Vinega
Roundworm
Trichinella
Trichinella encysted
Hookworm
Leech
Earthworm
Sandworm

29-1 Examples of common worms.

Drawings: Drawings are one of the most valuable tools in studying biology. They are particularly useful in showing the structure of organisms. Drawings can show structure more clearly than pictures.


mantle
shell
posterior adductor muscle
digestive gland
heart
esophagus
anterior adductor muscle
anus
excurrent siphon
incurrent siphon
mantle cavity
mou
mant
gill
shell
foot
stomach
intestine
reproductive or

30-8 The structure of a clam. The arrows indicate the direction of water flow through the mantle cavity and the gill (gray area).

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Organizing Information

Students must be able to organize data into a structure which shows interrelationships. To do this they must be able to note the author's organization and then produce his own organization. They note the patterns of thought in paragraphs and larger segments and then apply the skills of outlining, summarizing and notetaking.

Outlining. Once students are able to recognize the main ideas and their relevant details, they are prepared to organize these ideas on planes or levels of importance. The teaching strategy, following the model of introduction, focused practice, reteaching, and more practice, would be to examine a chapter and discuss outlining. Several types of exercises can be provided. Some exercises should show students how to reduce sentences to topics by removing the irrelevant words from the sentence. Other exercises help students distinguish topics from sub-topics. Exercises on the base form of outling can be followed with those in which students complete a skeleton outline.

Summarizing. Summarizing requires describing the author's message as briefly and clearly as possible. A summary procedes naturally from a good outline. Karlin (6) suggests several types of exercises for outling.

1. choosing the best sentence to summarize a paragraph.
2. choosing the best sentence that summarizes a longer selection.
3. Restate the author's idea in a single sentence.
4. Restate the author's ideas in a paragraph by combining the author's ideas into shorter statements.
5. Recognize different types of paragraphs and their functions.
6. Choose from several summaries the more preferable one.

Notetaking. Notetaking serves the purpose of making study active. The students must think and then rewrite the information. A second purpose is that the notes will make reviewing easier.

The students ability to take notes will depend on several skills, such as their ability to use introductions and summaries, bold face headings, paragraph analysis, and structural words which signal direction of the author's thought.

Shepherd (15) suggests several notetaking principles.

1. Notes should be taken in students' own words.
2. Notes should be brief.
3. Notice hints to structure, such as, first, more important, finally, remember, the essential difference is.
4. Students should be encouraged to invent codes and abbreviations.
5. Notes should be consistent in form and be orderly.
6. Notes should be filed in consecutive order and dated.

Shepherd also suggested several notetaking classroom procedures.

1. Read a chapter or section and discuss ideas which should be noted.
2. Discuss the most efficient form for their notes: outline, list, chart, timeline, parallel columns.
3. Guide class notetaking by writing main points on the blackboard.
4. Use newspaper article to note who, what, when, where, etc.
5. Use outline to show interrelationships of main ideas and supporting detail.

In a final note, Shepherd (15) cites McKay in providing a number of ways in which teachers can help students in organizing information.

Teachers can help students by

1. Being aware of the values and patterns of organization himself.
2. Asking questions which encourage looking for structure.
3. Previewing the next class with students to show the organization.
4. Alerting them to headings which almost outline the material.
5. Reading materials to the class and asking anticipating questions with focus on structure.

6. Using visual aids such as colored overlays on an overhead.
7. Showing students how to take notes and how to outline.

Following Directions

Following directions is a skill which is constantly being called on in the classroom. Students need careful training to perform properly and directions must be clear and unambiguous. Karlin (6) suggests developing this skill in four stages: (1) begin with one-step directions, (2) proceed to two step directions (such as, count and record), (3) then three or more simple steps (such as, measure length and width and record), and (4) finally introduce directions for which the number of steps is not stated explicitely.

Shepherd (15) provides a strategy for reading directions consisting of several steps.

1. Read the entire instruction for an overview.
2. Read each step.
3. Do as directed.
4. Reread the step to check.
5. Go on to next step.
6. Proceed until finished.
7. Reread entire directions as a final check.

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Project CAPABLE

CLASSROOM ACTION PROGRAM:

AIM: BASIC LEARNING EFFICIENCY

"to make each student a more capable learner"

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FEBRUARY REPORT

"MANAGEMENT TECHNIQUES"

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TITLE IV: PART C
DEVELOPMENTAL GRANT

SCIENCE

Paul Germann

Content area teachers have often been frustrated by many students inability to learn their subject matter. The students seem to lack certain skills that are basic to learning. In order to make each student a more capable learner, we must strive to use content to improve learning skills and use improved learning skills to learn content.

The student learning experience is composed of two factors which affect learning: first, the individual student, and second, the classroom learning environment. The individual brings with him a unique composite of emotional and physical maturity, attitudes, aptitudes, abilities, interest, vocational objectives, cultural background, previous knowledge in the subject area, and basic learning skills. This means that each students' approach to learning is like no one else's.

Each unique student is expected to learn in the classroom learning environment. Each classroom has its own set of factors that influence learning. These include: the number of students, the range of abilities of those students, the individual characteristics of the teacher, the content that is to be learned, and the degree of independence of learning that is expected.

The teacher is responsible for providing an appropriate, supportive, responsive, learning environment for each student. He is faced with a complex and intricate task as he attempts to devise activities which effectively lend all of the characteristics of the individual student with all of the elements of the classroom learning environment. The teacher must be ready with activities for each combination of topic, relevant learning skill, and student ability level. Besides this, an effective method of evaluating and keeping track of student achievement and ability must be used.

With so many factors to take into consideration and plan for, a comprehensive and systematic approach must be used to manage classroom learning.

Mastery Learning

Our expectations of student learning would seem to dictate our approach in the classroom. In many respects, the results we obtain in our classroom is a product of what we expected to get before we began. If we expect our evaluation results to conform to the classical standard distribution and the bell shaped curve, we may prepare, teach, and evaluate in subtle and unconscious ways that insure such a result.

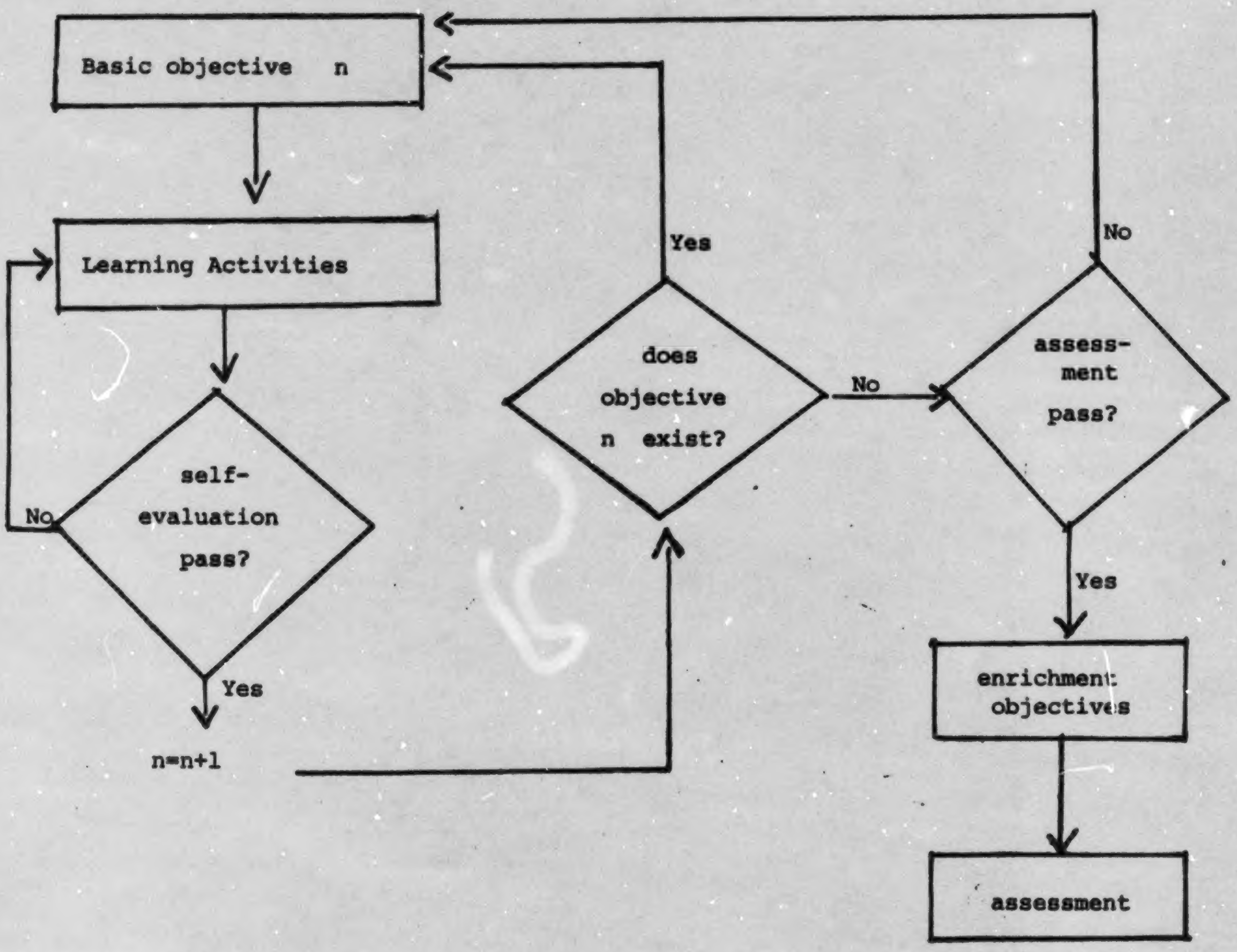
I propose that we take more positive approach. I suggest that we set out a basic level of competency that we expect all students to master. We understand that many students will be able to do a great deal more than this basic level, so we are ready with material that will allow them to attain a level of learning restricted only by their own skills and abilities.

Some educators suggest that students should not go on to the next unit or chapter until he has mastered the last one. The problem with this is that some students get stuck on some objective, spinning their wheels. This may result from a lack of interest and motivation, or because their cognitive processes are not ready to accept the concept yet. Many of us have learned a concept days or weeks after the original learning encounter. Subsequent concepts were valuable in helping us accomodate and assimilate the information.

To allow students to progress entirely at their own rate, raises another difficulty for the classroom teacher. It isn't long before students have spread themselves out with respect to achievement of objectives. Typical class sizes are much too large for the teacher to cope with the management of learning resources under such diverse circumstances.

Because of these problems it might be effective to provide for several levels of understanding and evaluation. First of all, self-tests can be written to allow students to check their own learning. The teacher can provide alternative exercises when difficulty is encountered. By a pre-determined date, all students should take a formal evaluation on the basic criteria. When they pass this test with adequate competency, they turn to enrichment activities. Students who do not pass will have few more days to encounter new and alternative exercises to help them with those criteria that are giving them difficulty. On a final assessment date, all students will be evaluated and will proceed to a new unit of study.

Figure 1: Mastery Learning


Basic objective n
Learning Activities
self-evaluation pass?
No
Yes
n=n+1
does objective n exist?
Yes
No
assessment pass?
No
Yes
enrichment objectives
assessment

Classroom Action Program

The Classroom Action Program is a management system designed to provide content area teachers with a practical plan for accomodating the tremendous range of individual differences in the students, the variety of classroom goals and objectives, the large quantity of learning resources, and the numerous alternatives of teaching/learning strategies. Such a plan should enhance the effective presentation of content through realistic and obtainable learning options for students.

Leslie B. Anderson (4), in a project at Lewiston Junior High School, provides us with a model in classroom management that we can adapt to our own project.

Our Classroom Action Program will be made up of four phases: (1) the preparation phase, (2) the instructional phase, (3) the supplementary activities phase, and (4) record keeping. This model will incorporate a modified mastery learning approach as suggested earlier in this paper.

The Preparation Phase: Preparation and planning is a key element to the success of this comprehensive approach to learning. All of the numerous and diverse elements of the classroom learning environment must be given adequate attention. This phase would consist of 12 steps: (1) course philosophy, (2) course goals and objectives, (3) unit goals and objectives, (4) outline of the chapter and marginal notes, (5) concept map, (6) chapter goals and behavioral objectives, (7) evaluation, (8) learning strategy worksheet, (9) learning strategy, (10) select or write exercises, (11) calendar, (12) student guide and check list.

Course Philosophy: The teacher must begin by carefully considering what the students need to know and why. There must be a critical assessment of the instructional goals in the light of the experiences and potential needs of the students. This leads to a deliberate analysis and synthesis of relevant and legitimate topics of study.

Course Goals and Objectives: Flowing naturally from the course philosophy will be the course goals and objectives. The teacher must consider what broad goals should be covered as described in the philosophy and then select those schemas concepts and skills which must be covered to accomplish those goals.

Unit Goals and Objectives: After describing the overall objectives of the course, the teacher considers how these will be organized into manageable units of study. Analysis of the textbook and other resources plays a role in this step. The teacher should not be tied to the texts' presentation, however. He should feel free to rearrange the presentation of material to suit the needs of his students. The textbook and other resources are tools for learning. Instruction and learning should not be dictated by these tools, but rather, by the desired outcomes.

A structural overview of the entire course would be of great benefit to both teacher and student in this step. The structured overview will show the relationships between topics to be covered in the course and help the teacher make decisions as to the appropriate order of presentation. Students will give valuable insight concerning the organization of the course content. They can appreciate the course as an integrated whole rather than a series of topics.

Outline of the Chapter and Marginal Notes: The teacher next turns to the individual chapter of material he intends to cover. These are the manageable units of work that can be prepared for the students to learn. Since the text is one of the central learning resources of a course, the teacher should become very familiar with it. The text needs to be carefully analyzed as to the content it presents, the skills the students will need to obtain that content, and how the text needs to be supplemented with other content and resources. The best way for the teacher to do this is to perform SQ3R himself on the chapter. In the "record" step he should outline. This will provide him with a written overview of the chapters content. When he sees that certain skills will be needed, he should make a marginal note in his copy of the text.

Concept Map: The teacher must now make a concept map for the chapter of material. Concept maps are structure diagrams that show the relationships between schemas, principles, and concepts in a graphic or pictoral way. There are a variety of structure diagrams (figure 2) that can be used to show relationships in various ways. The important thing is that the teacher must have a good overview of the chapters' content and its concepts if he is to be able to help students learn. The concept map will show the order in which topics must be taken up to provide a logical, well ordered, step by step, learning strategy.

Chapter Goals and Behavioral Objectives: Now that the content of the chapter has been analyzed, the concepts need to be considered in the light of the course and unit goals and objectives. Overall chapter goals must be selected which are consistent with the overall design of the course. The teacher next writes behavioral objectives which will accomplish the chapter goals. Care must be taken to see that concepts, principles and schemas will be properly developed through these behavioral objectives.

Three levels of objectives should be chosen. At the lowest level are those basic objectives which are absolutely necessary for minimal mastery of the chapter. The next level should be basic-plus. These are additional behavioral objectives which will enhance the understanding the chapter goals. The third level of objectives are enrichment objectives that will take students to the limits of their abilities. As often as possible they should be open ended. There should be flexibility along with options and choices in order to respond to individual differences among students.

Evaluation: The next preparation step is writing the tests for evaluation. The test questions should come directly from the behavioral objectives. No questions should be asked that are not mentioned in the objectives. Each objective should be tested at the literal and interpretive levels of comprehension.

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Figure 2

STRUCTURE DIAGRAMS

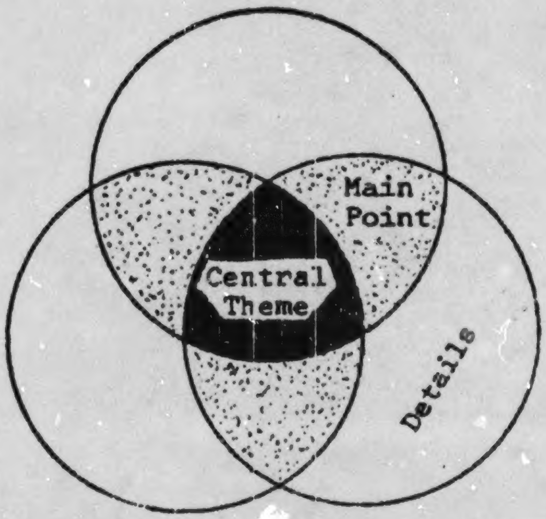
The structure of a schema, principle or concept is dependent upon the relationships among the parts, as well as the parts themselves. Illustrated here are several possible structure patterns which graphically demonstrate the organization of parts and various relationships among the parts.

OUTLINE

I. General topic
    A. Main point
        1. Detail
            a. Subdetail
            b. Subdetail
        2. Detail
            a. Subdetail
            b. Subdetail
            c. Subdetail
        3. Detail
            a. Subdetail
            b. Subdetail
    B. Main Point
        1. Detail
            a. Subdetail
            b. Subdetail
            c. Subdetail
        2. Detail
            A. Subdetail
etc.

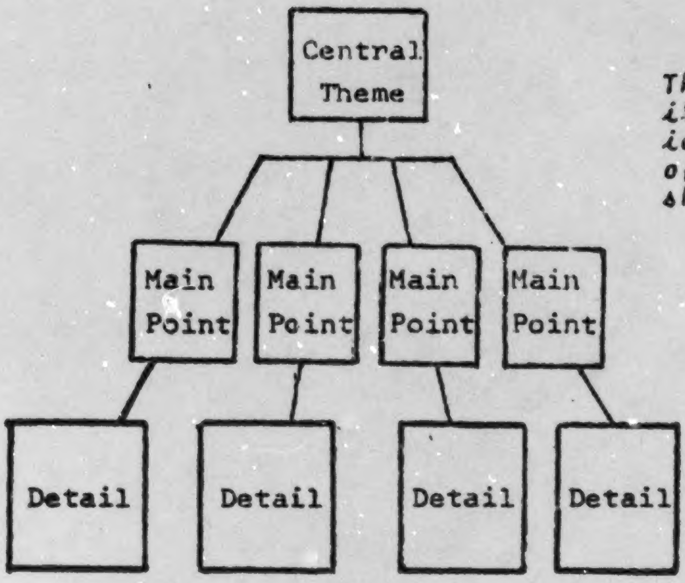
The outline form of structure illustrates organization based on one direction with descending importance. This structure might be used where the material would progress in a time sequence or step by step.

OVERLAPPING STRUCTURE



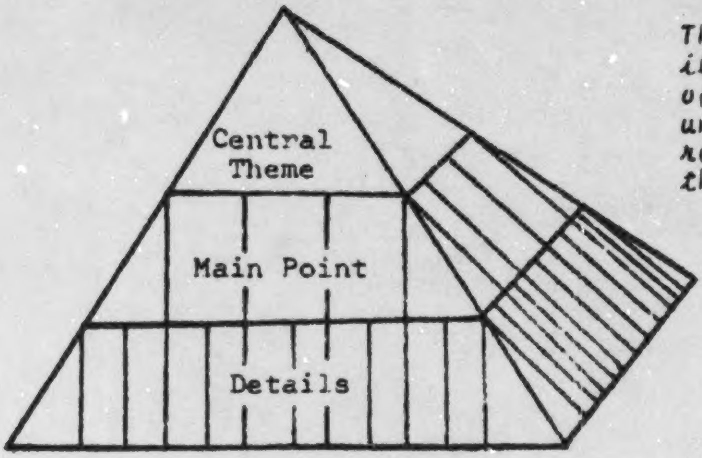
The overlapping form of structure illustrates organization where the parts intersect and overlap with each other, and where the organization is not made up of clearly separate ideas. The areas of overlap illustrate the merging and blending of ideas which form higher and higher levels of meaning.

PYRAMID


Central Theme
Main Point
Main Point
Main Point
Main Point
Detail
Detail
Detail
Detail

The pyramid form of structure illustrates different directions of support and the unity of ideas through the relationship of each part to the whole.

PYRAMID


Central Theme
Main Point
Details

The pyramid structure diagram illustrates several directions of support and identifies the unity of the ideas through the relationship of each part to the whole.

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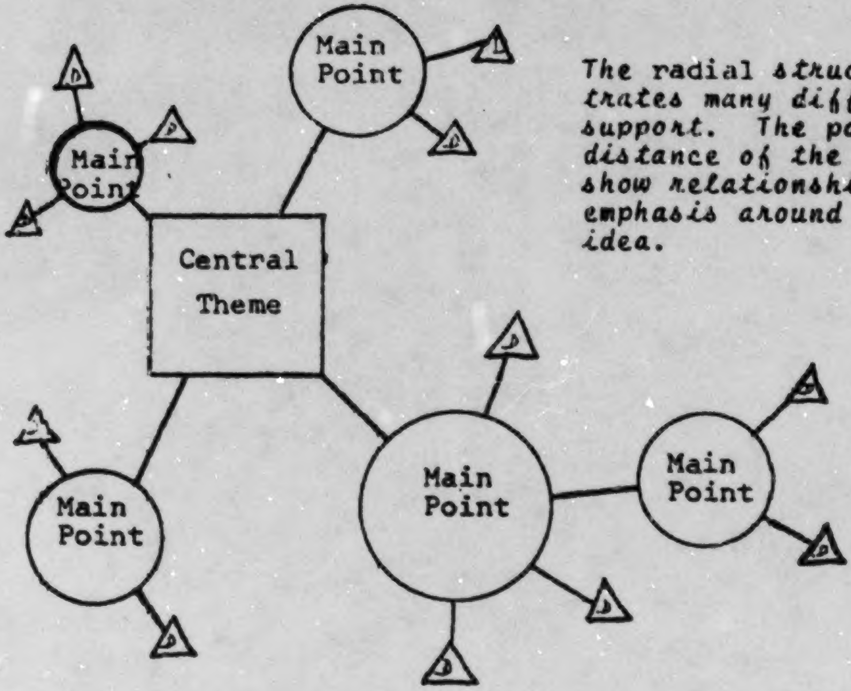
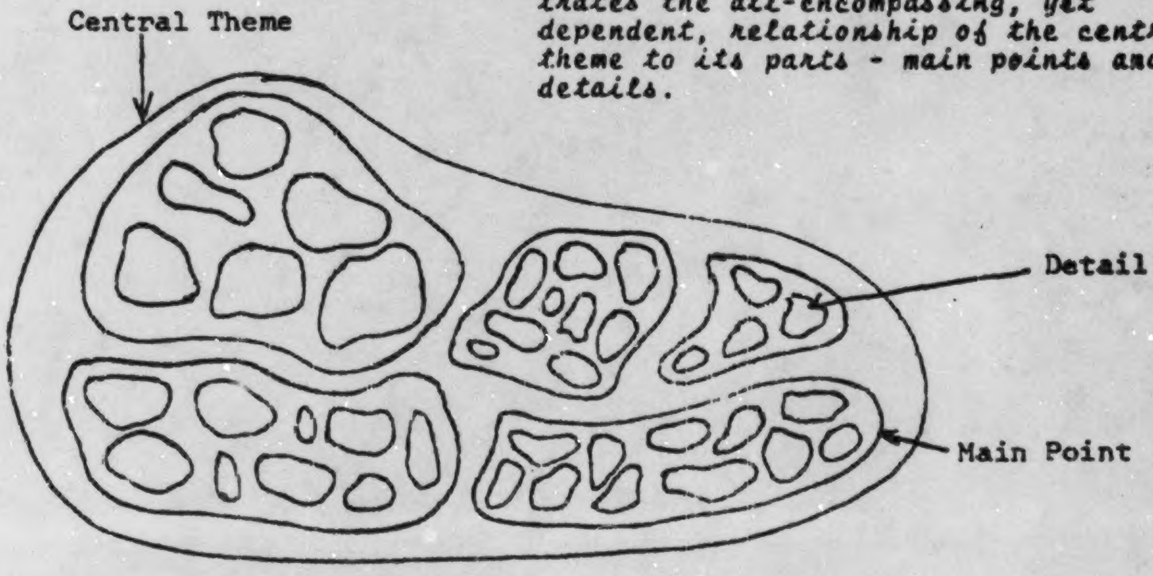
RADIAL


Main Point
Main Point
Central Theme
Main Point
Main Point
Main Point
D

The radial structure diagram illustrates many different directions of support. The position, size, and distance of the structural parts show relationships of unequal emphasis around the nucleus of an idea.

CELLULAR

The cellular structure diagram illustrates the all-encompassing, yet dependent, relationship of the central theme to its parts - main points and details.


Central Theme
Detail
Main Point

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For Mastery Learning, evaluations will have to be written for each level of mastery. Also, students should be provided with self tests on the objectives so that they can check their own progress. Evaluations at the enrichment level need not be formal tests. Other types of evaluation might be used, such as, a written report, a model, or an oral report.

Learning Strategy Worksheet: The learning strategy worksheet is useful in coordinating the learning resources with the behavioral objectives. The text, lessons, filmstrips, worksheets, labs, and other activities are reviewed to see which objectives they touch on. This information is summarized on the worksheet. The teacher can now see at a glance which learning activities can be used for each objective when he constructs the learning strategies.

Learning Strategies: Now the teacher can map out a multi-level system of learning strategies. Students should be grouped according to achievement for each learning skill, i.e. comprehension, critical thinking, vocabulary, SQ3R, study skills, etc. Three levels of achievement, beginning, intermediate, and advanced, can be set up and exercises written for each.

Select or Write Exercises: Several structural overviews, study guides, concept development exercises, DRTA and skill development exercises need to be selected or written for each of the 3 levels of student skill achievement.

Calendar: All of the classroom strategies have been set down: A calendar should be written which describes when each lesson, activity and homework assignment is to be done. Deadlines for evaluations are also set. There should be a deadline for taking the test over the basic material. Following this a flexible schedule should be made so that some students may do remedial work while others proceed to the basic plus and enrichment levels. A final deadline is established, at which time all work on that chapter ceases and the class goes on to the next.

Student guide and check list: The teacher has organized this maze of objectives, learning skills, and learning resources into an organized learning strategy. He must provide a student guide and checklist to assist them through the learning program. Students will gain security in knowing what is expected of them at any particular time and in future activities.

Instructional Phase

The Classroom Action Program is ready for the students. The first item of business will be to establish purposes for the chapter and to develop a learning framework into which the concepts of the chapter will fit. Structural overviews developed in the preparation phase will be introduced at this time.

Next the teacher will review with the students an overview of the learning strategy, the calendar which describes when activities are to be done, and the student guide and checklist. As soon as students understand what is expected of them, learning will begin through the planned activities. Some activities will involve the whole class, while others will be for small groups or individuals. Burmeister (2) suggests that whole class learning is appropriate when introducing new ideas or skills, discussing the same chapter with all students, viewing a film or filmstrip, or sharing individual work.

Small groups may consist of pairs, pairs of pairs, or 3, 4, 5 or 6 students. The groups will be formed for some reason. They may be achievement groups, skill groups, interest groups, social groups, or random groups.

Achievement groups are implemented when materials at different levels of difficulty are used. In this case the groups should be homogeneous. The students share a common ability in the required skills. Another way in which groups can be formed based upon achievement is heterogeneously. In this case, the better students are distributed among all groups to help those with poorer skills.

Skill grouping is based upon dividing students according to differences in attainment of particular skills. These groups also can be homogeneous or heterogeneous, depending upon the materials and the purpose.

Interest groups are formed by students who share a common interest so that they can share the same materials. In social groups the students are divided according to their social background. The groups may be homogeneous, in which they pool their common experiences, or heterogeneous, in which they share their different backgrounds.

Some exercise are best done on an individual basis. Such exercises might be those designed to improve specific skills, seek individual areas of interest, provide opportunities to select their own reading materials, or proceed at their own pace.

There are a number of ways in which teachers can form these groups. Random groups can be formed in some arbitrary way. On some occasions, the teacher's intuition can be effective. Formal and informal assessments are a very important source of grouping criteria. All of this information can be summarized on an index card for each student. The cards can be easily sorted to form groups. The information on the cards can be constantly updated as a students skills improve.

Burmeister suggests constellation grouping as logical and meaningful classroom strategy where whole class, small groups, and individual activities are blended together in an overall approach. Phase one in this strategy is whole class activities for orientation and general instruction. Phase two has small groups, based upon achievement, skill, interest or social criteria, meeting to participate in learning activities. In phase three students work on personalized activities designed for their particular skills and/or problems. Finally, in phase four, students meet in small groups and/or as a class to share interests and/or learnings.

Supplementary Activities

As a result of the mastery learning technique, many students will finish the basic and the basic-plus objectives before other students and be ready for enrichment exercises. These exercises can be individual or small group activities designed to take students above and beyond the basic requirements of the course, limited only by their own skills and talents.

Recordkeeping

Basic Objective	Activity	Self-test +/-	Activity	Test +/-	Activity	Retest +/-
1						
2						
3						
4						
5						

Basic+ Objective						
1+						
2+						
3+						
4+						
5+						

Enrichment	Activity	Evaluation
1E		
2E		
3E		
4E		
5E		

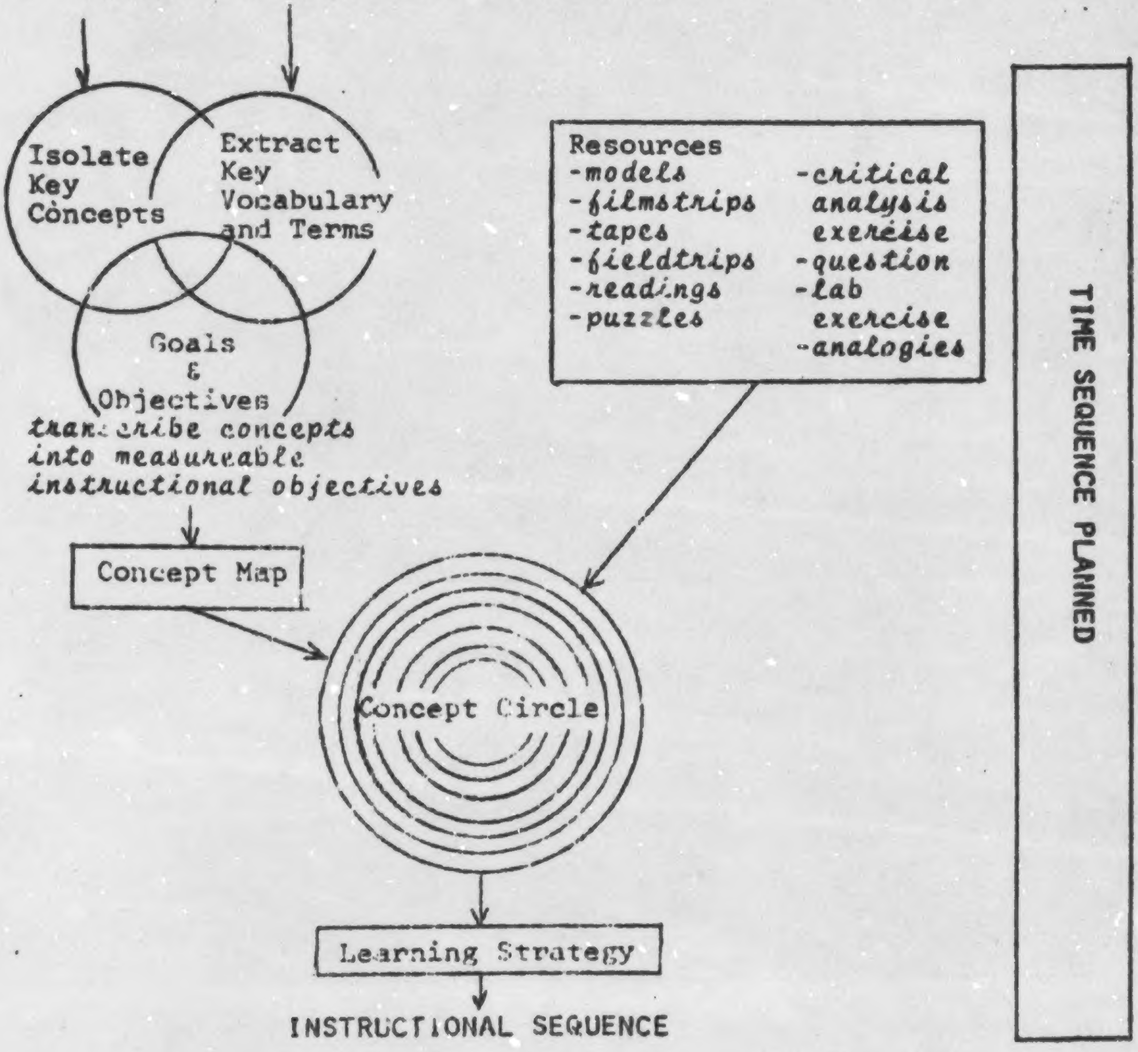
THE CLASSROOM MANAGEMENT SYSTEM

The Classroom Management System is designed to provide content area theacers with a practical plan for accommodating the tremendous range of individual differences in reading ability. This plan does not compromise content area expectations, rather, it enhances the effective presentation of content through realistic and obtainable learning options for students.

PREPARATION SEQUENCE

The deliberate analysis and synthesis of relevant and legitmate topics of study.

A critical assessment of instructional goals geared to the experiences and potential needs of the students.


Isolate Key Concepts
Extract Key Vocabulary and Terms
Goals & Objectives
transcribe concepts into measureable instructional objectives
Concept Map
Resources
-models
-filmstrips
-tapes
-fieldtrips
-readings
-puzzles
-critical analysis exercise
-question
-lab exercise
-analogies
Concept Circle
Learning Strategy
INSTRUCTIONAL SEQUENCE
TIME SEQUENCE PLANNED

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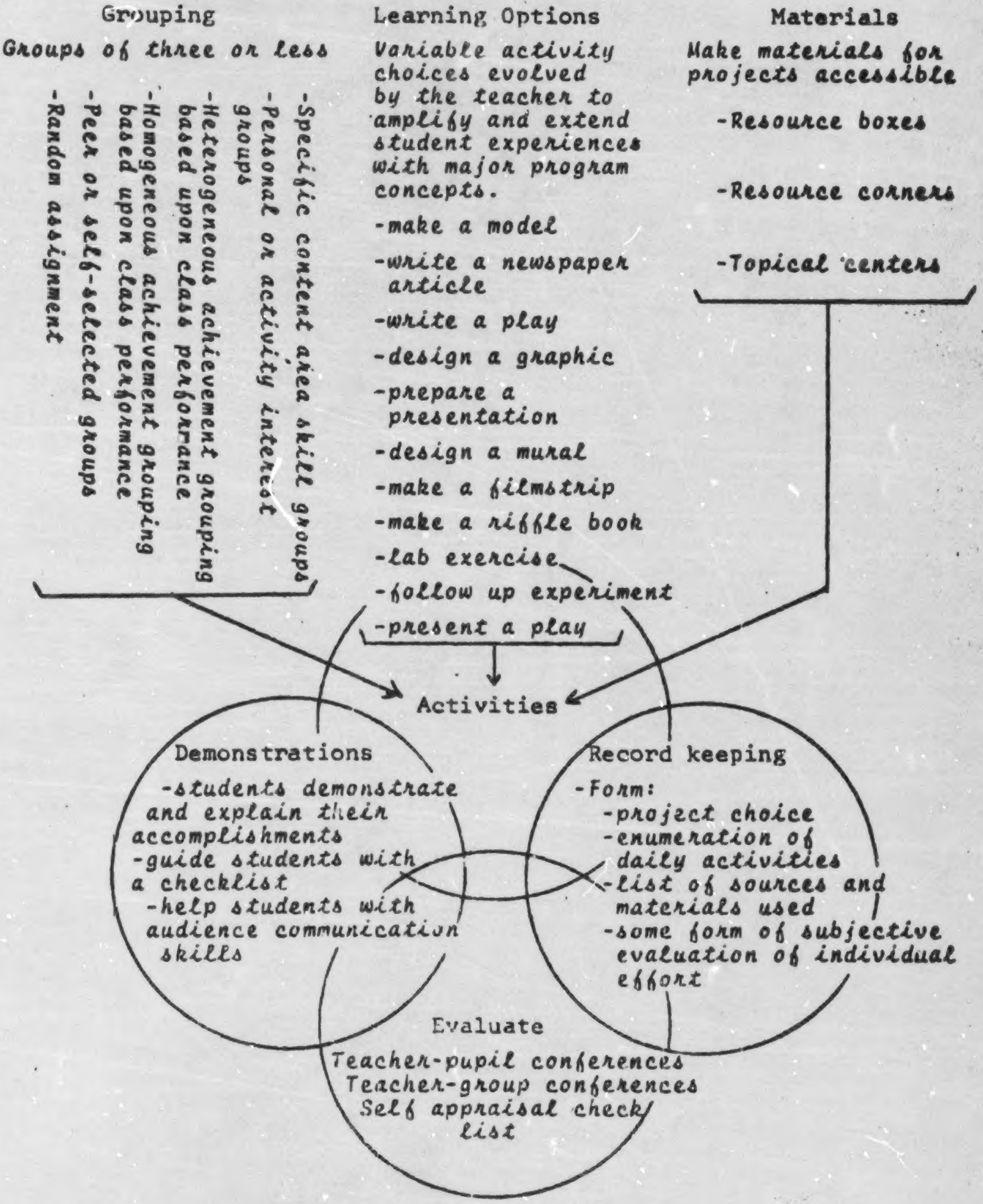
THE CLASSROOM MANAGEMENT SYSTEM

INDIVIDUAL AND GROUP ACTIVITIES



Grouping

Groups of three or less

- -Specific content area skill groups
- -Personal or activity interest groups
- -Heterogeneous achievement grouping based upon class performance
- -Homogeneous achievement grouping based upon class performance
- -Peer or self-selected groups
- -Random assignment

Learning Options

Variable activity choices evolved by the teacher to amplify and extend student experiences with major program concepts.

- -make a model
- -write a newspaper article
- -write a play
- -design a graphic
- -prepare a presentation
- -design a mural
- -make a filmstrip
- -make a riffle book
- -lab exercise
- -follow up experiment
- -present a play

Materials

Make materials for projects accessible

- -Resource boxes
- -Resource corners
- -Topical centers

Activities

Demonstrations

- -students demonstrate and explain their accomplishments
- -guide students with a checklist
- -help students with audience communication skills

Record keeping

- -Form:
  - -project choice
  - -enumeration of daily activities
  - -list of sources and materials used
  - -some form of subjective evaluation of individual effort

Evaluate

Teacher-pupil conferences
Teacher-group conferences
Self appraisal check list

THE CLASSROOM MANAGEMENT SYSTEM

SUPPLIMENTARY LEARNING ACTIVITIES

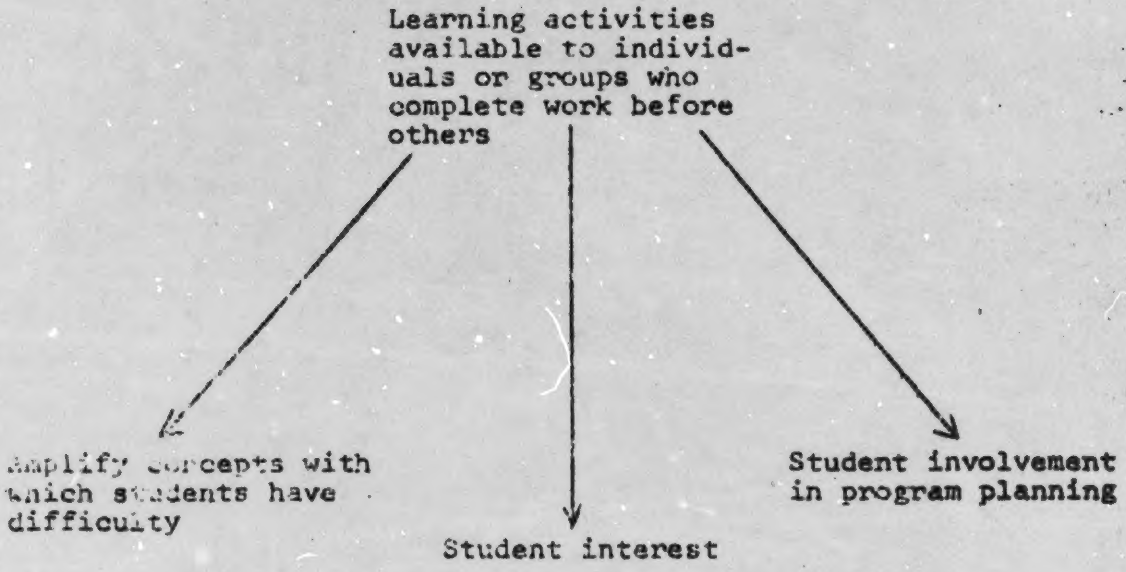

Learning activities available to individuals or groups who complete work before others
Amplify concepts with which students have difficulty
Student interest
Student involvement in program planning

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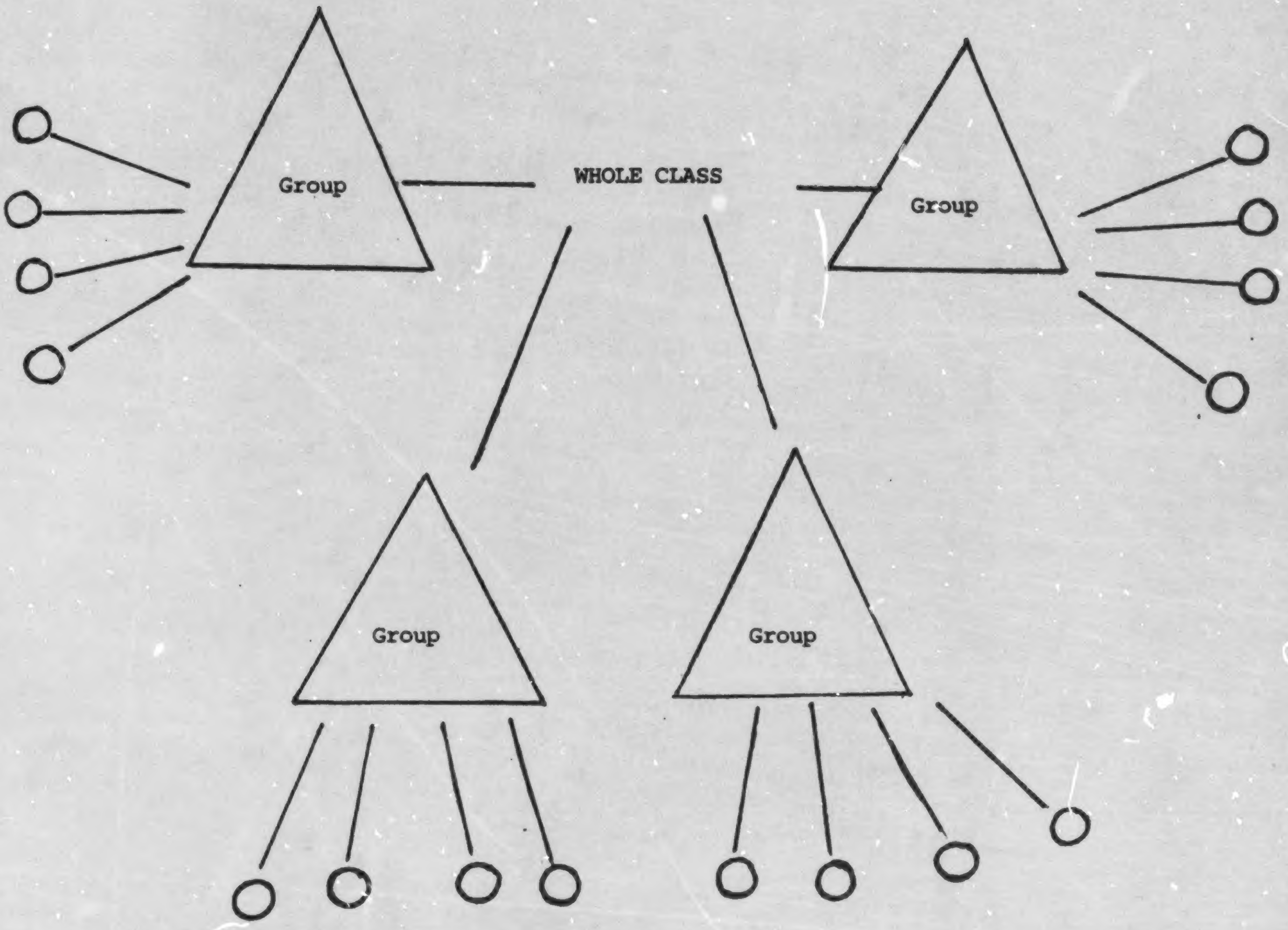
Figure 3: Constellation Grouping


Group
WHOLE CLASS
Group
Group
Group

CLASSROOM
ACTION
PROGRAM
AIM:
BASIC
LEARNING
EFFICIENCY

STEP 1: COURSE PHILOSOPHY

TOWARD A PHILOSOPHY OF SCIENCE EDUCATION

During the past several years we have been in the process of re-evaluating our science courses in America in the light of the criticism that has been leveled at these courses as they have been taught on all levels - elementary, secondary, and college.

Morris H. Shamos, in an article in The Science Teacher, points to a disturbing paradox. In a world which depends upon the fruits of science to such a large extent, the vast majority of our population is scientifically ignorant. In light of all that has happened in the past few decades to point up the significant role of science in this and future generations, so many students avoid to display their ignorance of this field as a badge of honor. Science teachers must ask themselves why this is so since whatever exposure our population has had to this discipline has been of their making. It would seem that either science is basically unteachable or we have yet to learn how to teach it properly. We seem to feel that it is important to impart upon our students a basic literacy in literature, art, music, history, social problems, etc. but fail to see the importance of developing a common literacy in science.

Just look at the curriculum of any high school or college. High schools require several courses of English, history, religion (in church related schools), but require only one year, if any, of a science. Our liberal arts colleges require several courses of such areas as philosophy and history. In high school, science is suggested only for those who intend to go on in the sciences upon entering college. In college, science is suggested for science majors only.

What is meant by a common literacy in science? Obviously, we don't mean that our students be able to solve scientific problems by themselves. This is the task of the specialist. Nor do we mean that our students should have an encyclopedic knowledge of scientific facts. Facts by themselves do not constitute what science really is.

What is meant by a common literacy in science is that an educated man should know science for his own good. It is a part of his culture just as are history, philosophy, literature, and the fine arts. He should have a certain sophistication in science so that he feels comfortable when reading or talking with others about sceince on a non-technical level. And he should have a sense of security about his everyday observations; a feeling that he understands his environment reasonably well. He should know facts of nature, not as a substitute for science, which is too often the case, but he should understand how these facts are used in developing major concepts in science. To do this we must base our science education upon ideas that will be remembered and not upon trivia.

As in other tasks, the best place to begin is at the beginning with a description of what science is all about. The scientific enterprise has three distinct aspects: descriptive science, technology (or applied science), and science (or pour science). To teach an adequate appreciation of the scientific enterprise we must teach a balance of all three of these aspects; taken alone each would provide a distorted view of the nature of science.

The major part of the curriculum of most elementary, high school, and introductory college courses are often comprised of descriptive and applied science. This type of curriculum is self-defeating in two ways. First of all, scientific knowledge tends to increase in a logrithmic fashion. If the doubling time for the amount of scientific knowledge is ten years, then there is about 220 times as much to learn today in 1980 as there was in 1900, and by the year 2000 there will be 2000 times as much to learn as there was at the beginning of the century. Secondly, at the present rate of research in the Western world, it is estimated that the median science is revised about every fifteen years. The gross implication of this revisionary process for science education is obvious. It means that the notion of coverage, of conveying the current knowledge of a field, which was once the essence of science teaching, is called into question.

For a society like ours, which is more and more becoming dependant upon the products of scientific research, to be democratic, the non-scientist must understand the nature of the dominating forces in their lives. The traditional course has been a literary treatment of science as a rhetoric of conclusions, and inquiry divorced from the data which supported them and the conceptual frames which define - and limit - their validity. Not only can we not keep up with the rapidly increasing number of conclusions, but this way of teaching science gives the false image that science is knowledge which is literally true, permanent, and even complete. We must not just teach alot of facts about science, or even alot of important concepts and principles. All of these are important. But far more important than any of these facts and concepts is that the learner understand the nature of this process whereby man acquires new understandings of life and of his universe. He needs to see that the scientist trys to subjugate the complexities of nature to the limitations of the available method or research. He needs to see the readiness with which the inquirer moves to challenge the soundness of his own work and to start afresh. Most of all, he needs to understand the conditional truth of scientific knowledge. Wherever possible, he needs to see the specific, concrete conditions which limit the truth and the applications of the bodies of knowledge his is taught.

A PHILOSOPHY OF EDUCATION IN THE BIOLOGICAL SCIENCES

The students should have a basic understanding of science and scientific processes. This is to build a scientific literacy in order to aid in the preparation of the students for later responsible citizenship. The aim should be to teach science as a way of thinking, as a way of seeking answers. To do this, we stress underlying concepts and understandings. Student work is centered in the laboratory where real problems are explored; open-ended experiments and other materials are used as the media for conveying an understanding of science. Through emphasis on basic concepts and illustrations of such concepts in many varying ways the student should be given practice in drawing generalizations, in seeking relationships, and in finding answers.

Step 2: COURSE GOALS AND OBJECTIVES

BIOLOGY COURSE GOALS

The goals of a high school biology course should be:

1. to give the students an understanding of the place of science among other intellectual and esthetic persuits; briefly, to see the science as being themselves a humanistic enterprise as much as literature, the arts, history, and religion, connected closely with them while differing from them.
2. to free the student from unreasonable fears that stem from ignorance by increasing their knowledge and appreciation of a world of living things around them.
3. to give students the opportunity to develop critical reasoning.
4. to give students a scientific background in the basic biological schemas and concepts that will enable them to be literate in the world of current biological advances and thereby be more able to make rational judgements concerning these advances as well as being more comfortable when reading or talking about science on a non-technical level. These biological schemas would be:
    A. the relationship of cause and effect - the student should understand that things don't just happen by themselves, but have definite causes.

B. The history of biological discoveries and concepts - the student should appreciate how scientific ideas grow and develop, and how mistakes and the limitations of method confine and restrain the concept at a particular time.

C. scientific method and procedures - the student should have experience in orgainizing and planning procedures through lab work, be able to do critical thinking and express themselves precisely in working with theoretical and practical problems in biology, and be able to draw conclusions from data or evidence so that their judgement of a cause is cautious and objective.

D. the nature of life through an understanding of the cell and cell energy processes - the student should understand that the basic unit of all living things is the cell and the cell is structurally complex carrying on many complex chemical processes.

E. genetic continuity, reproduction, and development - the student should understand why like begets like, the various methods by which like begets like, and how a complex organism can develop from a single cell.

F. diversity of type and unity of pattern with organic evolution - the student should understand the forces behind the theory of organic evolution and that while these forces create many different kinds of organisms, they are basically very similar.

G. ecological relationships - the students should understand how organisms inter-react with their environment and through this understand the problem of pollution of the environment so prevalent today.

Step 3: UNIT GOALS AND OBJECTIVES

OBJECTIVES OF UNIT ONE: THE NATURE OF LIFE

In Unit One we will be concerned with the Nature of Life. We will try to uncover, if we can, what the quality of "life" is, or, in other words, what do living things have that make them living and thereby different from non-living things. We begin by investigating those things that all living things do that non-living things do not. We will assume that they are able to do these things because they have "life." This does not tell us what life is (Chapter II)

We discover that the basic working unit of life is the cell. Therefore, to understand what life is and how organisms composed of cells function, we will have to take a close look at the cell's structure and inner workings.

To prepare ourselves for this investigation, we study some simple chemistry. This is necessary because we soon learn that the structures of the cell are composed of chemical compounds and that any activities a cell does is done by means of chemical reaction. (Chapter III)

With this foundation we are prepared to study the parts of the cell and what they do. (Chapter IV) Next we look at several chemical and physical phenomena which control the cell's environment: homeostasis, permeable membranes, diffusion, diffusion pressure, osmosis, passive and active transport, turgor pressure, cytolysis, plasmolysis, and pinocytosis. (Chapter V)

Our consideration of the cell then takes us to major cellular processes, in particular, those involved in providing the energy necessary for life and those involved in coordinating the vast number of activities in the cell: photosynthesis, respiration, cell energy, DNA control of the cell, DNA coding, protein sythesis. (Chapters VI & VII)

We consider how cells grow and how they reproduce so that we can better understand how organisms grow and reproduce and thereby insure that life is passed on from generation to generation. (Chapter VIII)

Finally, we will again consider what "life" is. We will consider two viewpoints: the vitalist who considers life to be a spiritual force which causes living things to be alive, and the Mechanist who explains life in terms of chemical and physical principles and laws.

Step 4: OUTLINE OF CHAPTER AND MARGINAL NOTES

Chapter Thirteen - Organic Variation - Outline

I. Our Changing Earth

II. A Story Written in Rock

III. Life on Earth

IV. Organic Variation

V. Paths of Evolution

VI. Lamarck's Theory of Evolution

VII. Darwin's Theory of Natural Selection

VIII. Mutation Theory of Evolution

IX. Gene Mutations and Change

X. Effects of the Environment

XI. Migration and Variation

XII. Change in the Environment

XIII. Isolation as a Factor in Evolution

XIV. Speciation

XV. Adaptive Radiation

XVI. Convergent Evolution

I. Our Changing Earth

A. Earth's 5 billion years old
B. Earth's constantly changing
C. Change takes place too slowly to notice

II. A Story Written in Rock

A. Sedimentary rock records earth's history
B. Rocks can be dated from radioactive elements
C. Gives us a calendar of earth's history

III. Life on Earth

A. Early Earth atmosphere compound of ammonia, methane, water vapor
B. energy from lightning changed gases in organic molecules
C. when right organic molecules come together, life began

IV. Organic Variation

A. Earth contains fossil record in sedimentary rock, amber

1. countless different organisms have developed on earth

B. A Clear pattern

   1. simple organisms present from early times
   2. complex organisms present from more recent times

C. Evolution is change

   1. old forms decline, new forms appear.

V. Paths of Evolution

A. Evidence for evolution

   1. homologous organs

      a. parts that are similar in structure, but may have different uses

         1. differences reflect adaption to environment
         2. likenesses indicate genetic relationship through a common ancestor

   2. Vestigial Organs

      a. structures that have no useful purpose in an animal, but do in related species.

         1. coccyx, ear muscles

   3. Embryos

      a. embryos of related species are very similar in early growth

   4. Chemical similarities

VI. Lamarcks Theory of Evolution

A. Theory of Need

   1. plants and animals change because they need to change

B. Theory of Use and Disuse

   1. organs weaken and disappear when they are not used

C. Theory that acquired traits can be passed on to offspring

VII. Darwin's Theory of Natural Selection

A. All organisms produce more offspring than can actually survive
B. Every Organism faces a constant struggle to survive
C. The individuals of a given species vary
D. The individuals that are best adapted to the environment survive. (Survival of the fittest)
E. The Organisms that survive pass their traits on to offspring
F. Organisms vary whether the need to or not. Whether a variation is helpful or not depends upon the environment.

VIII. Mutation Theory of Evolution

A. Mutations occur often in all organisms
B. Mutations are the basis for evolution

IV. Gene Mutations and Change

A. Mutations are found in all plants and animals
B. Mutations do not show up more often because

1. rate is slow 1/2000
2. most have slight effect
3. nearly always recessive
4. often are lithal

X. Effects of the Environment

A. Organisms vary because of (1) mutations, (2) new combinations as a result of sexual reproduction
B. Environment determines if variation is good or bad

1. environment controls direction of evolution

C. A change in environment occurs in 2 ways

1. migrate to new environment
2. environment change

XI. Migration and Variation

A. Migration: movement of animals from one environment to another

1. immigration: new variations into population
2. emmigration: into new environment

XII. Change in the Environment

A. Peppered moth

XIII. Isolation as a Factor in Evolution

A. allows gene pools to become different

1. 2 groups become more and more different

B. isolation from

1. barriers
2. mating times
3. mating habits
4. structures that prevent mating

XIV. Speciation

A. A species is a group of organisms that are similar in structure and that can mate and produce fertile offspring.
B. speciation: the development of a species
C. forces of speciation: migration, change in environment mutation, natural selection, and isolation.

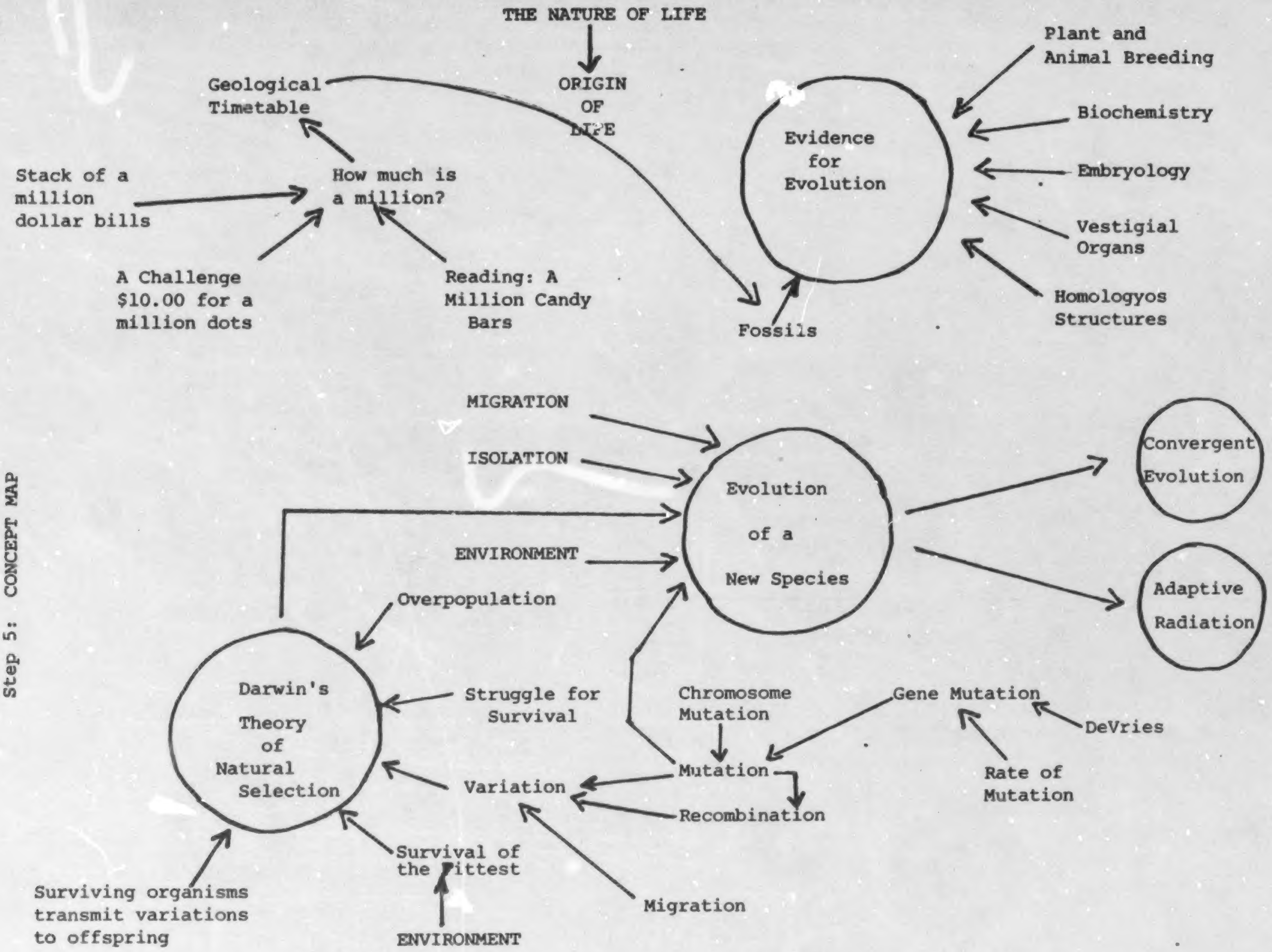
XV. Adoptive Radiation

A. Population branches out to new and different environment
B. Thru evolution they become different species

XVI. Convergent Evolution

A. organisms with different ancestors become more alike because they share the same environment

Step 5: CONCEPT MAP


THE NATURE OF LIFE
ORIGIN OF LIFE
Geological Timetable
How much is a million?
Stack of a million dollar bills
A Challenge $10.00 for a million dots
Reading: A Million Candy Bars
Evidence for Evolution
Plant and Animal Breeding
Biochemistry
Embryology
Vestigial Organs
Homologyos Structures
Fossils
MIGRATION
ISOLATION
ENVIRONMENT
Evolution of a New Species
Convergent Evolution
Adaptive Radiation
Overpopulation
Darwin's Theory of Natural Selection
Struggle for Survival
Variation
Survival of the Fittest
ENVIRONMENT
Surviving organisms transmit variations to offspring
Migration
Chromosome Mutation
Mutation
Recombination
Gene Mutation
DeVries
Rate of Mutation

Step 6: OBJECTIVES AND BEHAVIORAL OBJECTIVES

CHAPTER THIRTEEN: ORGANIC VARIATION

Objectives

1. Students should understand the evidence that evolution has taken place.
2. Students should understand the principles of Darwin's Theory of Evolution.
3. Students should understand how Darwin's Theory of Evolution provide an explanation as to how plants and animals on earth could have evolved.

Performance Criteria

Students should be able to:

1. Describe how the geological timetable is divided up; describe what evidence is used to make these divisions; and describe what the scientist uses the geological timetable for.
2. Give a general description of Oparin's hypothesis of the origin of life.
    - 2+. describe the details of Oparin's hypothesis.
        - 2E. make a series of drawings illustrating each stage of Oparin's hypothesis.
3. Explain how the geological timetable is actually a timetable of life.
4. Define evolution; orgainic variation.
5. List and explain five categories of evidence for evolution.
    - 5+. describe how the forelimbs of several vertebrates is evidence for evolution.
    - 5+. describe several examples of vestigial structures.
        - 5E. describe what is meant by "ontogeny recapitulates phylogeny."
        - 5E. describe several examples of biochemical similarities as evidence for evolution.
        - 5E. describe how a sixth category of evidence, plant and animal breeding, is evidence for evolution.
6. List and describe how the three theories in Lamarck's explanation of evolution were false.
7. List and explain the five chief factors in Darwin's theory of natural selection that account for the development of new species from a common ancestry.
    - 7+. construct a graph showing the typical overpopulation curve.
    - 7+. list several possible limiting factors which may cause struggle for survival.
    - 7+. construct and explain a graph showing the typical population curve for a population and a limiting factor (such as, preditor-prey).
        - 7E. research and report on how Darwin's five factors may have caused the evolution (change) of some organism.
8. Describe the contribution of DeVries to the theory of evolution.
9. Describe the relationship between mutation and Darwin's theory of natural selection; describe the consequences if mutations did not occur.
10. List and explain three causes for organic variation among the individuals of a population.
    - 10+. list several reasons why helpful mutations do not occur very often.
    - 10+. describe the relationship between sexual reproduction and variation.
        - 10E. describe why it is good that mutations do not occur very often.

11. Explain isolation as a factor in evolution.
    - 11+. list several kinds of isolation barriers.
12. Define species; speciation.
13. List the factors involved in the development of new species.
    - 13+. describe how these factors work together to produce a new species.
14. Define convergent evolution.
15. Define adaptive radiation.

Step 6: CHAPTER GOALS AND OBJECTIVES

Activities

Lessons

1. An understanding of geological/biological time Evidence that evolution has taken place.

2. Some theories of Evolution.

3. A close look at Darwinian Evolution.

4. Speciation and Common Ancestry.

Reading Assignments

1. Pages 148-150

2. Pages 150-154

3. Pages 154-159
   159-161

Handouts

Labs

1. The Role of Competition in Natural Selection from Stock & Bancheri #70.

2. Variation in Organisms (Grasshoppers) from Otto, Towle & Crider 13 - 1.

3. Variation (beans) from Weinberg #57.

4. The Effect of Protective Coloration in Evolution from Stock & Bancheri #79.

Filmstrips

A. What is Evolution
B. Darwin and Evolutionary Thought
C. Natural Selection
D. Migration and Isolation
E. Evolution of Man
F. Cultural Evolution

Set: None

Micro-Slide Viewer: None

Prepared microscope slides: None

Step 7: EVALUATION

Matching

A. acquired characteristics
B. adaptive radiation
C. biochemical similarities
D. convergent evolution
E. chromosomal aberration
F. chromosome mutations
G. crossover
H. Darwin
I. DeVries
J. embryology
K. Fossils
L. gene mutations
M. geological timetable
N. haploidy
O. homologous structure
P. isolation
Q. Lamarck
R. migration
S. need
T. non-disjunction
U. overpopulation
V. plant and animal breeding
W. polyploidy
X. recombination
Y. Species
Z. struggle for survival
AA. survival of the fittest
BB. surviving organisms pass their characteristics on to the next generation.
CC. use and disuse
DD. variation
EE. vestigial structures

a. In blanks 6 through 11, list six types of evidence that evolution has occured.

b. organism parts that are poorly developed and not functioning but did serve a useful function in that organism's ancestors.

c. organism parts that are similar in origin and structure but not necessarily in function.

d. the imprint or preserved remains of an organism that once lived.

e. that a population tends to increase in size in geometric fashion until there are too many. The appendix, ear muscles, and "tail bone" of humans are these kinds structures - they indicate man's ancestry.

f. the study of the developing human shows that the human fetus has gill' slits, a yolk sac, and aortic arches, just as primitive organisms do.

g. In blanks 12, 113, and 14, list Lamarck's three theories of evolution.

h. plants and animals change because they need to change

i. organs remain active and strong when they are used, they weaken and disappear when they are not used.

j. traits acquired through need or use and disuse can be passed on to offspring.

k. list Darwin's 5 factors in his theory of evolution.

l. differences that occur among individuals of a species.

m. the father of modern evolutionary theory.

n. organisms compete with one another for something in the environment which has com to be critical.

MATCHING Con't.

o. organisms tend to reproduce at such a rate that leads to an eventual conflict over some factor in the environment.

p. those organisms with helpful variations survive better while those who do not have the helpful variation do not survive as well.

q. the scientist who suggested that the source of variation, which Darwin had suggested in his theory, was mutations.

r. in blanks 15 through 18, list four sources of variation.

s. during sexual reproduction there is the mixing and recombination of chromosomes.

t. when an organism moves into a new population it may bring new characteristics into that population.

u. a mistake in copy of the genetic code.

v. the confinement of a population to a certain location because of barriers.

w. a group of related organisms that interbreed and produce fertile of offspring in nature.

x. a branching out of a population through variation and adaptation to occupy many environments.

y. organisms of entirely different origin evolve in a manner that results in similarities.

z. a calendar of the ages formed by the layers of dediment which are pressed into rock.

(PC 1) The geological timetable is most like a(n)

a. calendar
b. sun dial
c. flat area of land that has existed for a long time
d. a time schedule for determing the age of rocks
e. all of the above
f. none of the above

(PC 1) The dates for the geological timetable were determined by

a. the density of rock layers
b. the location of fossils
c. radioactive analysis
d. calculations based upon the movements of the sun
e. all of the above
f. none of the above

(PC 1) The geological timetable is used to help describe

a. the density of rocks
b. how the earth has changed
c. how many hours it takes to analyze rocks
d. good seasons for planting
e. all of the above
f. none of the above

(PC 2) Which of the following gases was not in the ancient atmosphere?

a. ammonia
b. oxygen
c. methane
d. water vapor
e. all of the above
f. none of the above

(PC 2) The energy for making organic compounds came from

a. respiration
b. volcanic activity
c. the hot rocks of the ancient earth
d. lightning and radiation
e. all of the above
e. none of the above

(PC 2) The beginning of life in the 1st cell depended upon

a. the right combination of organic molecules
b. a spark of energy from solar radiation
c. a soul being "breathed" into the cell
d. the second law of thermodynamics
e. all of the above
f. none of the above

(PC 3) The geological timetable is also a timetable of life because

a. living organisms used it as a schedule for evolution
b. scientist can use it to record both geological and biological changes.
c. changes in the earth caused changes in organisms
d. organisms were created from the dust of the earth
e. all of the above
f. none of the above

(PC 4) When we study the individual members of a species we see that they are different from each other. The term that refers to these differences is

a. mutations
b. heterotrophs
c. speciation
d. organic variation
e. all of the above
f. none of the above

(PC 4) A slow process of change in which new forms of organisms appear and old forms decline or become extinct is called

a. evolution
b. bio synthesis
c. geological timetable
d. migration
e. all of the above
f. none of the above

(PC 6) Lamarck stated that traits acquired through need or use and disuse. This is

a. false, because acquired characteristics do not cause changes in the genetic make up and therefore cannot be passed on to the next question.
b. false, because traits cannot be useful
c. true, because any useful trait is also needed
d. true, because many traits are lost by disuse
e. all of the above
f. none of the above

(PC 9) If we assumed that species do not change, we would expect

a. the most complex fossils only in the oldest rocks
b. the simplest fossils only in the newest rocks
c. the same kind of fossils in both old and new rocks
d. no fossils in any kinds of rocks
e. all of the above
f. none of the above

(PC 9) If mutations did not occur

a. there would be no variation among members of a species
b. all the organisms in a population would be genetically identical
c. evolution could not take place
d. all members of a population would have an equal chance of survival
e. all of the above
f. none of the above

(PC 5) In man the appendix and ear muscles are examples of

a. vestigial organs
b. homology
c. natural selection
d. mutations
e. all of the above
f. none of the above

(PC 6&7) A plant has allele that gives it a survival advantage. Over time the percentage of this allele in the population increased. This is probably due to

a. use and disuse
b. mutation
c. natural selection

d. artificial selection
e. all of the above
f. none of the above

Application Questions

(PC 11) The next two items are based on the following information:

In a small pool in Nevada a type of fish known as the pupfish is found. This fish has the smallest range of any known vertebrate. It has existed in this pool since the Ice Age ended.

(PC 10) The limited range of this species is probably due to

a. hybridization
b. natural selection
c. geographical isolation
d. mutation.
e. all of the above
f. none of the above

(PC 8) Changes in the anatomy or physiology of this species are possible only if the fish were

a. to increase its reproductive rate
b. changed to another habitat
c. crossed with another species
d. to develop favorable mutations
e. all of the above
f. none of the above

(PC 11) Although Madagascar is separated from Africa only by a narrow strait, many plants and animals common on the mainland are unknown on the island. This fact illustrates the principle of

a. incomplete dominance
b. evolutionary equilibrium
c. evolution in isolated populations
d. succession
e. all of the above
f. none of the above

The next 5 questions are based on the following data and key.

A biologist made the following observations on two groups of salamanders. He noted that the two groups

Key: A. have a different coloration and arrangement of spots
B. have a common ancestor based on fossil record
C. live if different isolated habitats
D. will interbreed and produce fertile offspring

1 D ____ Which is the best evidence for the hypothesis that the salamanders are all of one species?

2 C ____ Which suggests that they exist in a condition which favors the evolution of separate species?

3 D ____ A change in which observed condition would eventually produce two separate species?

4 B ____ Which observation includes an interpretation of data?

5 A ____ Which condition could be altered by careful selective interbreeding in the laboratory?

(PC 6&7) According to modern concept of evolution, which of the following would be most correct? The giraffe developed a long neck because

a. it needed one and such a neck was passed on to the offspring
b. giraffes with long necks had a better chance to survive than those with shorter necks
c. a giraffe was born with a sudden change in neck length not present in either parent
d. the environment peculair to giraffes caused their long necks
e. all of the above
f. none of the above

(PC 6&7) If a species lived in an area where for centuries that had been a large number of preditors, and if this species had no means of defense other than running, you would expect that members of this species would

a. develop stronger legs because of much use
b. develop longer legs because they needed them to survive
c. be killed if they were slow and survive if they were faster because natural selection would occur
d. mutate in such a way as to cause longer legs to be produced in response to the animals needs.
e. all of the above
f. none of the above

(PC 6&7) Our present day horse is much larger than its original ancestors. Which statement below would help to explain this change, based on Darwin's reasoning?

a. sometime in the past a mutation occurred
b. early horses had to run fast to escape their enemies, thus they developed larger muscles and longer legs
c. larger horses survived, smaller ones perished, thus leaving only the bigger ones
d. after all the grass was eaten, early horses had to stretch for food on the trees, thus they developed longer legs and necks
e. all of the above
f. none of the above

(PC 6&7) When a mutation makes an organism better suited to the environment, that mutant gene will probably

a. increase in mumber
b. decrease in number
c. remain the same
d. can't say
e. all of the above
f. none of the above

(PC 9) Mutations are usually

a. dominant and lethal
b. dominant and/or non-lethal
c. recessive and/or lethal
d. recessive and/or non-lethal
e. all of the above
f. none of the above

(PC 10) Mutant characteristics show up in a population as a result of

a. isolation
b. recombination
c. migration
d. genus
e. all of the above
f. none of the above

(PC 6) A rat loses its tail. Those who believe that the rat's offspring will be born without tails are following the doctrine of

a. natural selection
b. the inheritance of acquired characteristics
c. mutation
d. survival of the fittest
e. all of the above
f. none of the above

(PC 7) Darwin based much of his theory of evolution on

a. the struggle for existence
b. mutations
c. environmentally acquired characteristics
d. the use and disuse of organs
e. all of the above
f. none of the above

(PC 10) Evolution can take place more rapidly among organisms which reproduce sexually than among organisms which reproduce asexually because

a. sexual reproduction is more hazardous than asexual, hence, only the fit survive
b. asexual reproduction is possible only for one-celled organisms
c. sexual reproduction is more likely to produce different kinds of offspring
d. sexual reproduction is slower than asexual reproduction in the production of offspring
e. all of the above
f. none of the above

(PC 10+) Some mutations are lethal because

a. a vital chemical reaction in the organism is blocked
b. the mutant produces a toxin that kills cells
c. the environment changes to produce a harmful effect

d. the altered DNA cannot produce the required ATP
e. all of the above
f. none of the above

(PC 9) If there were no variation among organisms of a species, new species would

a. not be produced
b. become larger in body size
c. become better adapted to new environments
d. be produced only by isolation and interbreeding
e. all of the above
f. none of the above

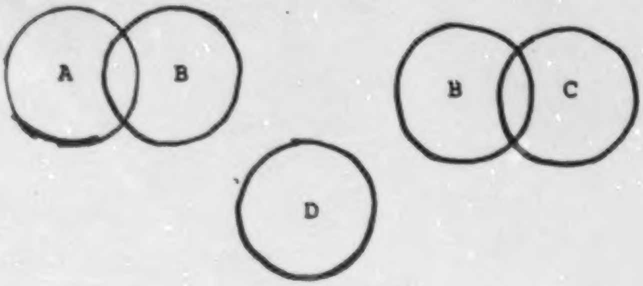
(PC 7) An inherited adaptation of a species is significant to evolution because certain members of the species will

a. reamin unchanged
b. find an environment where such an adaptation is not harmful
c. have less chance of survival
d. have a better chance of surviving
e. all of the above
f. none of the above

(PC 12) A new species of organism is formed when

a. a series of mutations occurs to cause an organism to be different
b. an organism is isolated from the rest of the species by a geographic barrier
c. the climate of a population changes drastically
d. a group of organisms can no longer interbreed with other closely related organisms
e. all of the above
f. none of the above

(PC 12) The next 3 questions are based on the following four populations that interbreed where the circles touch.



a. 1
b. 2
c. 3
d. 4
e. all of the above
f. none of the above

(PC 12) How many species would there be if population A disappeared?

a. 1
b. 2
c. 3
d. 4
e. all of the above
f. none of the above

(PC 12) How many species would there be if population B disappeared?

a. 1
b. 2
c. 3
d. 4
e. all of the above
f. none of the above

(PC 9) Knowing that environments vary over long periods of time, what must happen to pupulations of organisms if they are to survive?

a. new species must frequently be created
b. the reproductive rate must increase
c. such populations must cross breed with other populations to survive
d. members of the population must differ from one another for natural selection to operate
e. all of the above
f. none of the above

(PC 7) If a mutant allele gives an organism a slight advantage, what will happen to the allele?

a. since it is a mutation, it will soon be dropped from the gene pool
b. it will remain in the gene pool and have a selective advantage
c. dominant genes will mask it so its effect will not be noted
d. the mutants will come to be considered a different species after 10 generations e. all of the above f. none of the above

(PC 7) A given geographical area has a high pheasant population. This fact probably indicates that

a. the average age of pheasants in the population has increased considerably
b. the pheasant birth rate is low
c. there is a ratio of predators to pheasants that is higher than normal
d. pheasants are well adapted to this area
e. all of the above
f. none of the above

(PC 10+) Harmful recessive genes remain in a population of organisms because they are

a. retained for future survival value
b. controlled by the Hardy-Weinberg Law
c. recessive and carried by heterozygous individuals
d. cannot be eliminated except by increase in mutation rate
e. all of the above
f. none of the above

(PC 10) Sexual reproduction is a significant factor in organic evolution primarily because it provides for

a. the production of genes
b. the only means for the continuation of any species
c. great variation in offspring
d. changes in the way in which DNA duplicates itself
e. all of the above f. none of the above

(PC 7) Of 357 similar weeds germinating on a 2' x 3' plot of ground, only 62 reached maturity. Which of the following aspects of Darwin's theory of natural selection can best be applied to this observation?

a. all members of a species vary in their traits
b. many variations of a species are inherited
c. there is a struggle for existence among members of a species
d. variations are inherited by offspring and in time great differences arise
e. all of the above
f. none of the above

(PC 7) Natural selection, as described in Darwin's scheme of evolution, assumed

a. a stable unchanging population of animals
b. survival value of random differences
c. inheritance of environmentally acquired characteristics
d. environmental stimuli resulting in changes in body structure
e. all of the above
f. none of the above

(PC 7) Whether a variation is favorable or unfavorable to survival of the species depends

a. on the nature of the environment, as well as upon the nature of the variation
b. primarily on the nature of the variation
c. entirely on the environment in which the individual lives
d. on whether the variation is a dominant or recessive mutation
e. all of the above
f. none of the above

The next three items are based on the data about peppered moths.

A large number of dark and light forms of moths were captured and marked for identification. 488 dark moths and 496 light moths were released. 34 dark moths and 62 light moths were recaptured.

(PC 7) Which of the following would be the most reasonable assumption?

a. the moths were released in a forest with dark tree trunks
b. identical numbers of moths must be released
c. the moths were released in a forest which had many light tree trunks
d. the recaptured moths were too few in numbers of draw a conclusion
e. all of the above
f. none of the above

(PC 7) The moths were marked with paint on the under side because

a. it was easier for the investigator to identify recaptured moths
b. when held for painting, it was easier to mark them in this way
c. paint on the upper side might have introduced another variable
d. paint will wear off the upper side of the moths more rapidly
e. all of the above f. none of the above

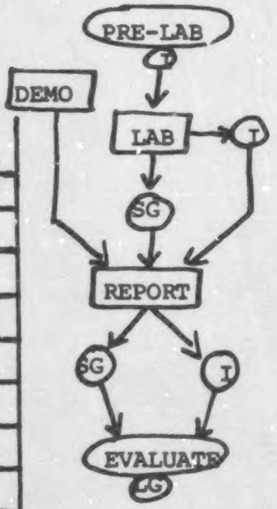
(PC 7) This experiment on moth populations provides data on

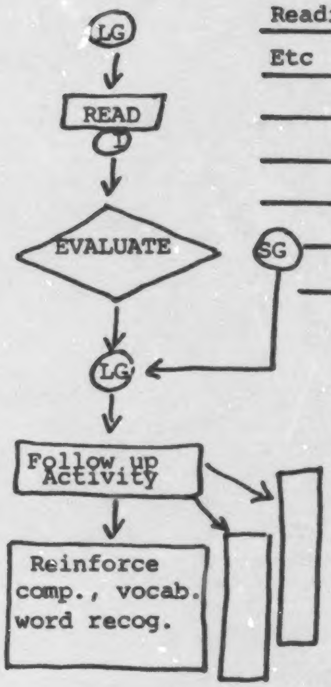
a. the effect of environment on survival of favorable variations
b. reproduction as a factor in maintaining populations of organisms
c. survival rate of moths in a forest environment
d. ability of a species to exist in an unnatural environment
e. all of the above
f. none of the above

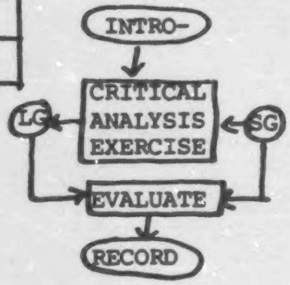
Included here is only the basic test. A student self-test must now be written, as well as a test for the basic+ level. Evaluations for enrichment exercises will be individual.

Step 8: LEARNING STRATEGY WORKSHEET

LEARNING ACTIVITIES	PERFORMANCE CRITERIA 1	2	3	4	5	6	7
Reading Ass							
Lessons							
Labs							
Filmstrips							
Readings							
Etc							


PRE-LAB
I
DEMO
LAB
I
SG
REPORT
SG
I
EVALUATE
LG

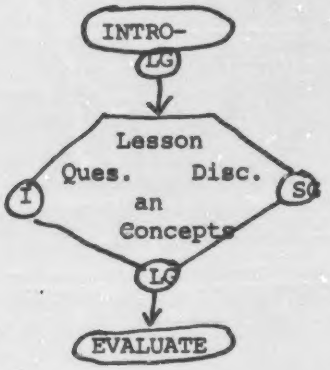

LG
READ
I
EVALUATE
SG
LG
Follow up Activity
Reinforce comp., vocab. word recog.

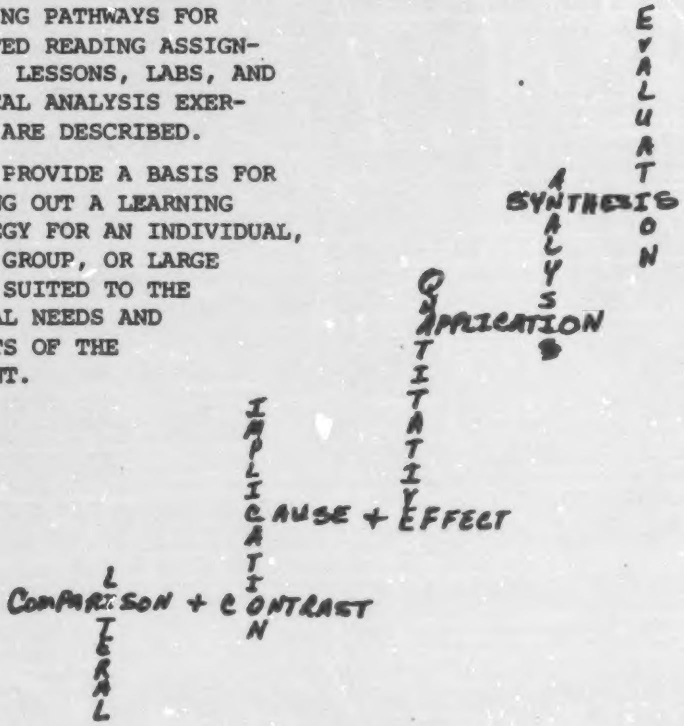

INTRO-
CRITICAL ANALYSIS EXERCISE
LG
SG
EVALUATE
RECORD

THE CONCEPT TABLE SUMMARIZES THE RESOURCES AVAILABLE TO LEARN THE IDEA PRESENTED BY EACH PERFORMANCE CRITERIA.

LEARNING PATHWAYS FOR DIRECTED READING ASSIGNMENTS, LESSONS, LABS, AND CRITICAL ANALYSIS EXERCISES ARE DESCRIBED.

THESE PROVIDE A BASIS FOR MAPPING OUT A LEARNING STRATEGY FOR AN INDIVIDUAL, SMALL GROUP, OR LARGE GROUP SUITED TO THE SPECIAL NEEDS AND TALENTS OF THE STUDENT.


INTRO-
LG
Lesson
Ques.
an
Concepts
Disc.
I
SG
LG
EVALUATE


EVALUATION
SYNTHESIS
ANALYSIS
APPLICATION
QANTITATIVE
CAUSE + EFFECT
IMPLICATION
COMPARISON + CONTRAST
LITERAL

CHAPTER 13:

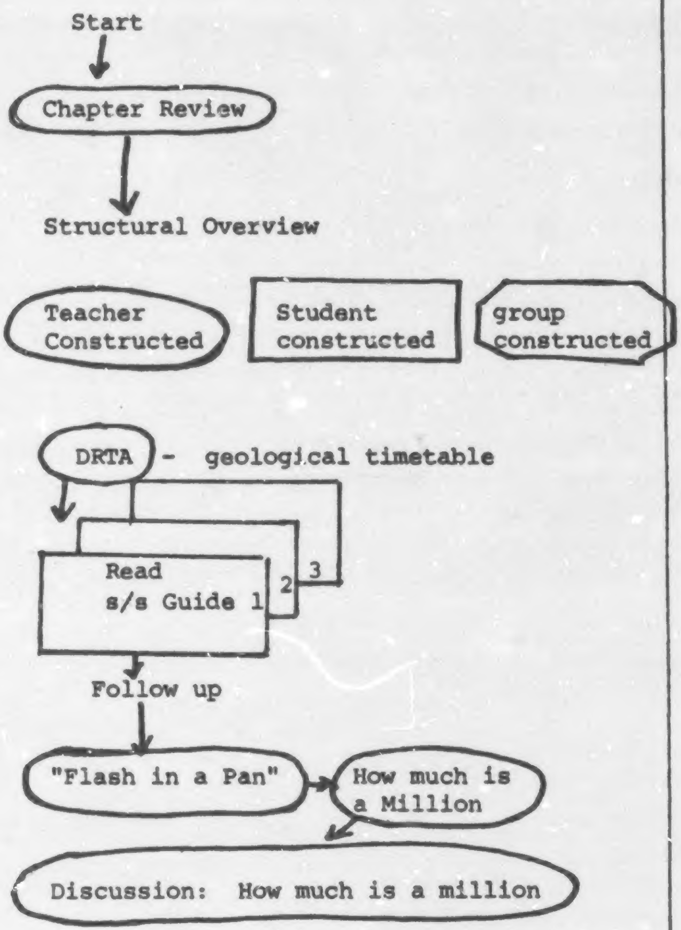
ORGANIC VARIATION

PERFORMANCE CRITERIA

	1	2	2 +	2 E	3	4	5	5 +	5 +	5 E	5 E	5 E	6	7	7 +	7 +	7 +	7 E	8	9	10	10 +	10 +	10 E	11	11 +	12	13 +	13	14	1
Reading Assignments																															
1. 148-150	✓	✓			✓																										
2. 150-154						✓	✓	✓	✓																						
3. 154-159													✓	✓					✓	✓	✓										
4. 159-161																									✓	✓	✓	✓	✓	✓	✓
Lessons																															
1. Organic Var/ Evidence	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓																			
2. Lamarck/Darwin/ DeVries													✓	✓					✓	✓											
3. Darwin															✓	✓	✓														
4. Speciation																									✓	✓	✓	✓	✓	✓	✓
Labs																															
1. Variation						✓																									
Filmstrips																															
1. What is evolution	✓				✓	✓	✓																								
2. Darwin & E.V. Thought	✓				✓	✓	✓						✓	✓	✓																
3. Natural Selection														✓																	
4. Migration & Isolation																									✓	✓	✓	✓	✓	✓	✓
Readings																															
"Flash in the Pan"	✓																														
"How much is a Million"		✓	✓	✓	✓																										
"In the Beginning"				✓																											

STEP 9: Learning Strategy

⬭ = whole class ☐ = individual ⬡ = groups
s/s Guide = study and/or skill guide

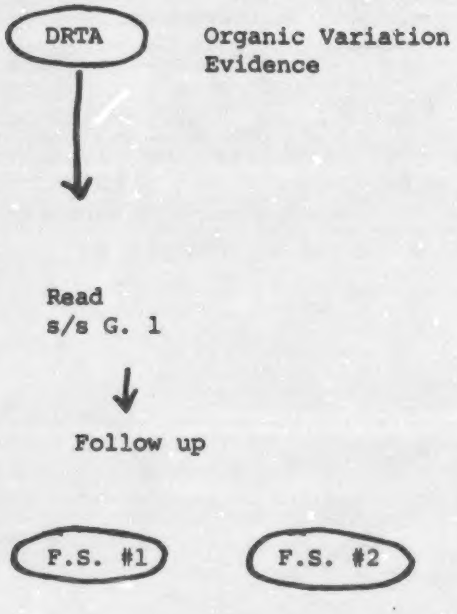

Start
Chapter Review
Structural Overview
Teacher Constructed
Student constructed
group constructed
DRTA - geological timetable
Read s/s Guide 1
2
3
Follow up
"Flash in a Pan"
How much is a Million
Discussion: How much is a million

NOTES
(SKILLS, CONCEPTS, ETC.)

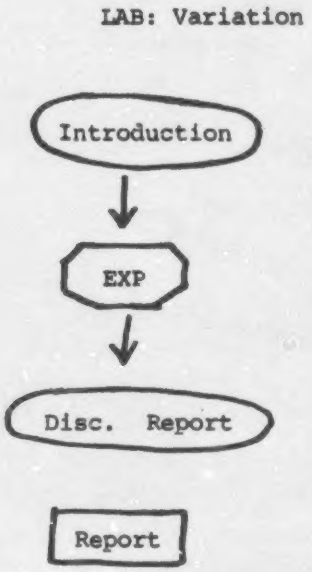
based upon chapter summary

reading a table; transitional paragraph; series of events; drawing

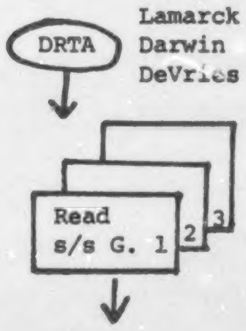
concept development lesson


DRTA
Organic Variation
Evidence
Read
s/s G. 1
Follow up
F.S. #1
F.S. #2

introductory paragraph; list of categories; understand a table; reading will need additional explanation.

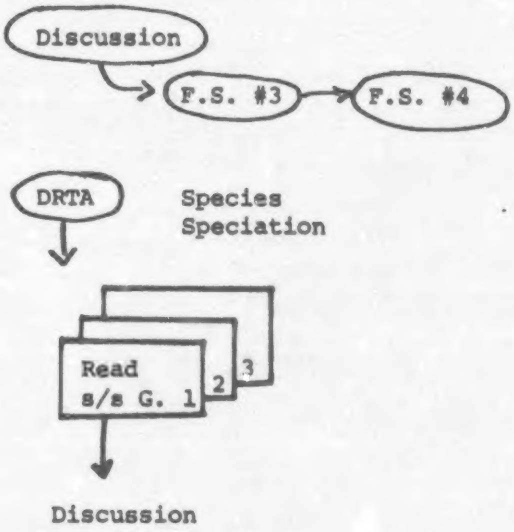

LAB: Variation
Introduction
EXP
Disc. Report
Report

setting of purpose & hypothesis
bar graphs
grouping of data
evaluation of data and conclusion


DRTA
Lamarck
Darwin
DeVries
Read
s/s G. 1
2
3

evaluation; list of ideas; selection of main idea

Follow up


Discussion
F.S. #3
F.S. #4
DRTA
Species
Speciation
Read
s/s G. 1
2
3
Discussion

EVALUATE = BASIC

Remedial Basic

Basic+	Resources
2+	"In the beginning" reprint "Origin of Life"
5+1	other biology texts
5+2	" " "
7+1	class work - find a source
7+2	" " " " "
7+3	" " " " "
10+1	" " " " "
10+2	" " " " "
11+	text - Filmstrip - classwork
13+	text - Filmstrip - classwork

Enrichment	I	Gc
2 E_1	I/G	
5 E_2	I	
5 E_3	I	
5 E_1	I	
7 E	I	
10 E	I	

Read: Inherit the Word	I
Act out: " " "	Gc
Construct a Crossword Puzzle	I
Word Find	I
Follow the Dot	I
Create a poster or bulletin board	I/G
Extend lab on Variation	I/G

Students assume responsibility of finding resource material.

Step 10: Select or Write Exercises

Several study or skill guides need to be written for each assignment, three study guides should be written, fundamental, intermediate and advanced levels. In some cases, supplementary readings must be selected. When a student is doing remedial work on Basic material, alternative readings and study guides must be written. Special readings and exercises must also be selected for basic-plus work. Instruction guides for enrichment exercises must be written.

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Step 11: Calendar

hapter review verview DRTA eological imetable	Read "How much is a million" Discussion DRTA Organic Variation Evidence	F.S. #1 F.S. #2 DRTA Lamarck Darwin Devries	LAB VARIATION		Discussion F.S. #3 F.S. #4 DRTA Species Speciation	Species Speciation
ead 148-150 S/S Gc lash in a Pan	Read 150-154	Read 154-159		Report due in 3 days	Read 159-161	Basic evaluation
Basic valuation	Basic + Remedial Basic	Enrichment		Final Evaluation		

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Project CAPABLE

CLASSROOM ACTION PROGRAM:

AIM: BASIC LEARNING EFFICIENCY

"to make each student a more capable learner"

CO-DIRECTORS

Paul Germann
Science

Terry Murphy
English

TEAM

Don Clavette
French

Mike Crawford
Social Studies

Claire Labrie
Science

Phyllis Perreault
Business

Kermit Pooler
Special Education

Gisele Roy
English

Harry Shea
Math

MARCH REPORT

"STRUCTURED OVERVIEWS & STUDY GUIDES"

TITLE IV: PART C
DEVELOPMENTAL GRANT

When guiding student learning we are confronted with an array of terms: Study guides, reading guides, comprehension guides, pattern guides, concept guides, process guides, skill guides, reasoning guides, etc. Many of these terms overlap in meaning and few, if any, have any precise, generally accepted definition.

The purpose of a guide of any kind is to help students cope with a learning situation with enough understanding that they can learn the significant and relevant information. The path to that understanding requires the successful application of the skills suggested by the variety of guides: reading skills, study skills, process skills, pattern recognition, concept development, levels of comprehension, the relationships between the ideas. Putting himself in the place of his students, the teacher is also on the look out for any information gaps. These are pieces of information the author assumes are in the students background. Their absence may hinder learning on the part of some students. In other cases, a concept might be enriched with additional information. At this same time, the teacher is selecting the points that he will test later.

A structural overview of the selection's concepts would be very helpful in this analysis. A structural overview is a diagram that shows the relationships between all of the major and minor concepts in the reading. Any graphic reasoning skills, etc. All of these are interrelated so that learning does not hinge on any more of them but on all of them together. Any learning guide presented in a content area classroom will probably have to target several skills at once, if understanding is to be achieved.

If we want students to comprehend better, the learning guide must model the appropriate behavior. The learner should be guided through the skill processes so that he can practice what is expected of him. Eventually, when he has mastered the skills, they will be useful to him whenever he needs them.

In order to prepare a learning guide, the teacher must make a pre-reading analysis of the selection. During this analysis, he asks himself several questions.

1. "What content is presented?" The teacher takes a close look at the selection to determine what the major ideas are? Not only must major concepts have to be separated from minor ones, but it is important to determine technique which helps demonstrate the organization of the ideas is permissible. Figure 1 shows several types of diagrams that can be used to show the structure of the material to be studied.

As the teacher develops the structural overview, he puts himself in the students place and trys to plan a logical, step-by-step presentation of concepts. In this way, he attempts to foresee any gaps of information that he will have to fill in.

The behavioral objectives should be checked to see that all relevant ideas have been addressed.

2. "How is the material organized?" The organizational patterns used by the author are important to obtain meaning from a selection. Many students will need help in recognizing and using such patterns as cause and effect, temporal, comparison and contrast, and listing. Structural overviews can be useful in guiding students through many of these patterns. Exercises which require students to match, classify, or reorder can be very helpful.

3. What understandins do I want students to gain?" Herber(7) suggests that the teacher first consider what information he would like the students to derive from the selection. He then composes several questions that will lead to these ideas. These questions will be at the interpretive level of comprehension.

The teacher next looks to literal comprehension. He writes questions which will elicit statements of fact from the text. Care must be taken not to paraphrase the text. Paragraphing the text turns the assignment into a "scavenger hunt" where students match question wording to answer wording, without any un-

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STRUCTURE DIAGRAMS

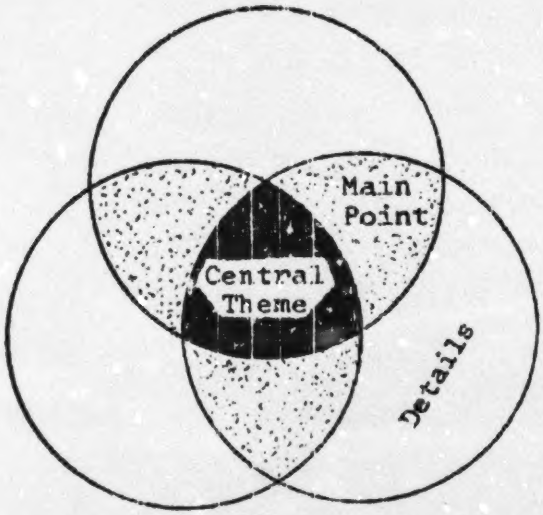
The structure of a schema, principle or concept is dependent upon the relationships among the parts, as well as the parts themselves. Illustrated here are several possible structure patterns which graphically demonstrate the organization of parts and various relationships among the parts.

OUTLINE

I. General topic
  A. Main point
    1. Detail
      a. Subdetail
      b. Subdetail
    2. Detail
      a. Subdetail
      b. Subdetail
      c. Subdetail
    3. Detail
      a. Subdetail
      b. Subdetail
  B. Main Point
    1. Detail
      a. Subdetail
      b. Subdetail
      c. Subdetail
    2. Detail
      A. Subdetail
etc.

The outline form of structure illustrates organization based on one direction with descending importance. This structure might be used where the material would progress in a time sequence or step by step.

OVERLAPPING STRUCTURE



The overlapping form of structure illustrates organization where the parts intersect and overlap with each other, and where the organization is not made up of clearly separate ideas. The areas of overlap illustrate the merging and blending of ideas which form higher and higher levels of meaning.

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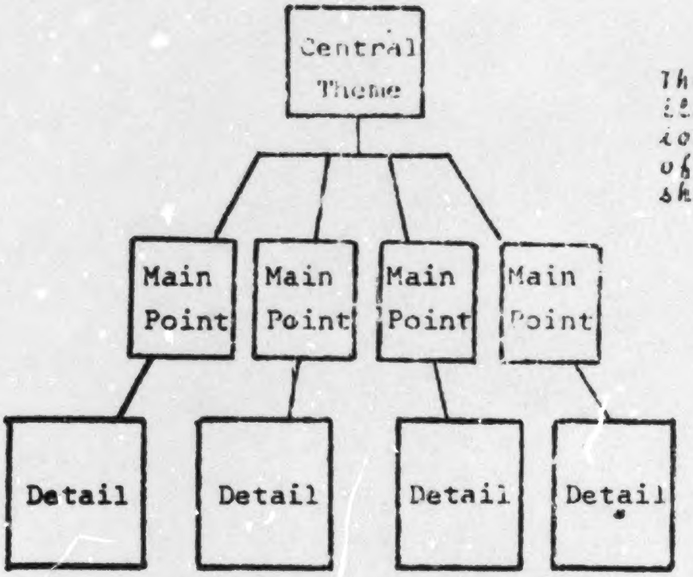
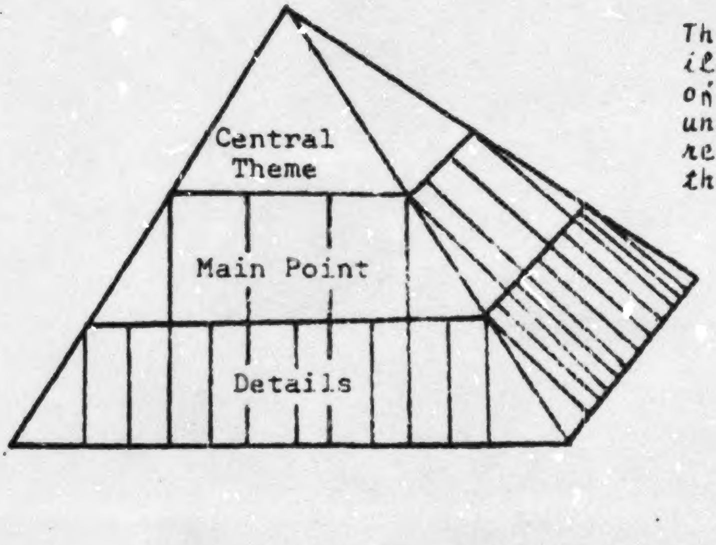
PYRAMID


Central Theme
Main Point
Main Point
Main Point
Main Point
Detail
Detail
Detail
Detail

The pyramid form of structure illustrates different directions of support and the unity of ideas through the relationship of each part to the whole.

PYRAMID


Central Theme
Main Point
Details

The pyramid *structure diagram illustrates several directions of support and identifies the unity of the ideas through the relationship of each part to the whole.*

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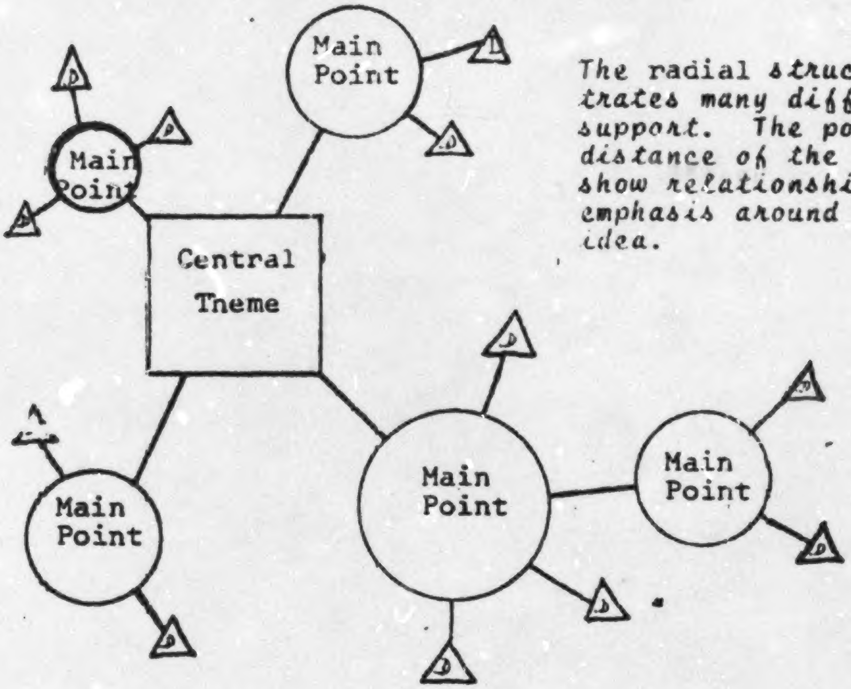
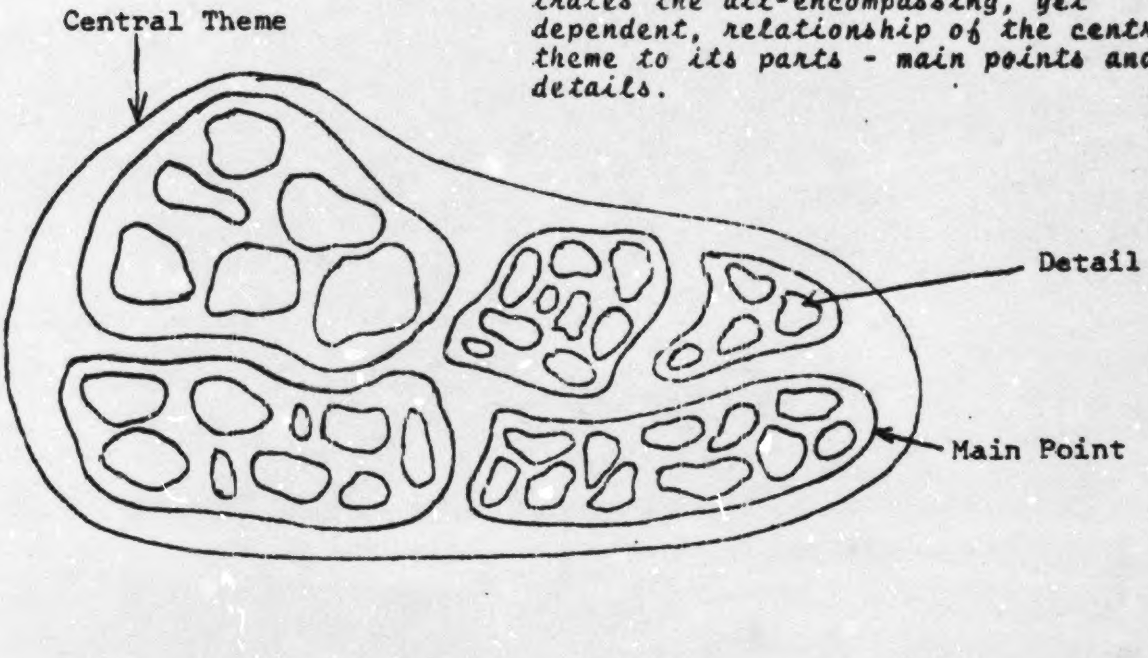
RADIAL


Main Point
Main Point
Central Theme
Main Point
Main Point
Main Point
D

The radial structure diagram illustrates many different directions of support. The position, size, and distance of the structural parts show relationships of unequal emphasis around the nucleus of an idea.

CELLULAR

The cellular structure diagram illustrates the all-encompassing, yet dependent, relationship of the central theme to its parts - main points and details.


Central Theme
Detail
Main Point

derstanding.

Now the text is analyzed to determine what are the most generalized conclusions that can be drawn from the text. These will be application questions. The student is asked to generalize, analyze, sythesize and apply.

These questions can be grouped according to their comprehension level, or, if they are all mixed together, each level can be denoted with a symbol.

4. "What vocabulary will students need help with?" The selection must also be analyzed for new and troublesome vocabulary. The learning guide can provide the extra help students will need with some of the vocabulary.

5. "What skills are required?" The teacher must also be on the look out for the various learning skills the student will need to use to get the needed information. When these skills are identified, specific exercises must be written to address these possible problem areas.

6. "What rate of reading should be used?" Cues should be written into the learning guide to help students adjust their rate of reading to the content.

While some reading guides may focus on one single problem area, the teacher will probably be trying to accomplish many of these goals at once. A word of caution, however - keep it simple. Don't try to do too much. While some of these skills will go well together and compliment each other, the student should be asked to focus on one thing at a time. He should also be aware of what skill you are trying to improve in each exercise.

Herber(7) suggests, also, that for students to be successful, there is a specific order in which skills must be developed. First, students must be aware of the various levels of comprehension. After this, they will be ready to understand organizational patterns. Finally, they can direct their attention to specific skills.

Steps for Preparing a Study Guide

1. Prepare an outline of the reading selection. Only the ideas you consider important enough to be tested should be included. These ideas should be reflected in the behavioral objectives for the chapter.

    What content is presented?
    Are there any information gaps?
    What background information is necessary?

2. Prepare a parallel outline which analyzes the selection in light of the skills needed to obtain the appropriate meaning from the selection. A skill checklist, such as the one in Figure , is a useful reminder in this analysis.

    How is the material organized?
    What understandings do I want students to gain?
        Which ideas are literally stated?
        Which ideas must students derive?
        Which ideas represent applications?
    What vocabulary will the students need help with?
        What kind of vocabulary help is needed in this context?
    What skills are required?
    What rate of reading should be used?

3. Write three levels of study guides for students at different mastery levels.

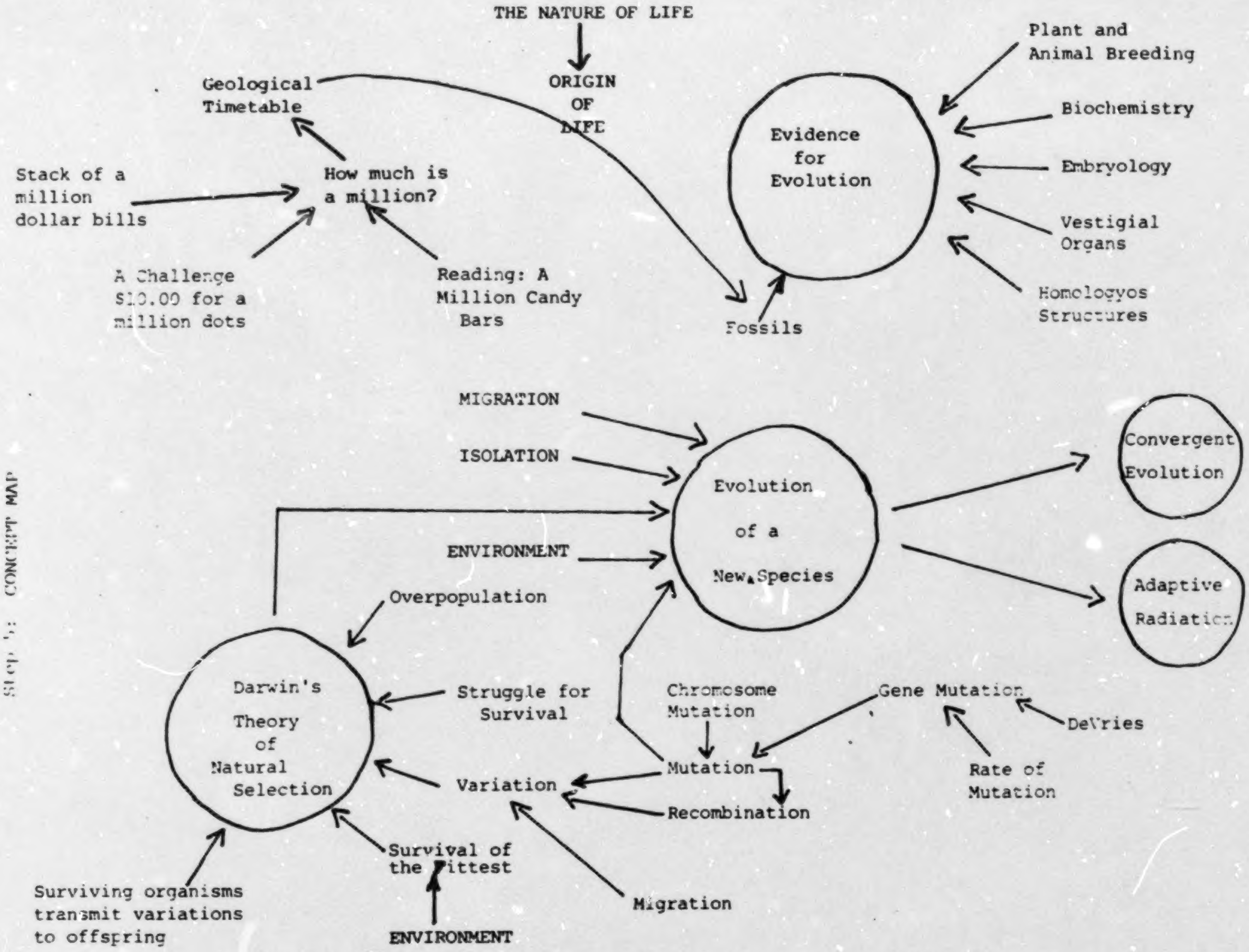
An Overall Skill Plan

The teacher should prepare at the beginning of the course an overall skill plan or timeline. This timeline is a plan of when each of the skills will get particular emphasis. The time of emphasis depends upon the nature of the material being used at the time. Such a plan ensures that the development of learning skills is not a hit or miss venture, but proceeds in an organized fashion.

COMPREHENSION	Literal	main idea supporting detail irrelevant detail follow directions sequence classify graphics
	Interpretive	comparison/contrast implication cause & effect quantitative
	Apply	application analysis synthesis
VOCABULARY	Types	general vocabulary technical vocabulary proper nouns flagged or joined words
	Skills	structural analysis word history synonym contextual analysis
RATE		preview survey skim to get overview skan to locate info quickly
		concept development

STUDY SKILLS	PARAGRAPHS	Types	explanatory definitional introductory summarize and conclude transitional narrative descriptive
		Comprehension	topic sentences main ideas of paragraphs main ideas of longer selections related detail unrelated detail
		Graphics	pictorial aids graphs tables charts maps cartoons diagrams
		Resources	table of contents index appendix Readers Guide card catalog glossary bibliography
		ORGANIZATION	paraphrase summarize outline

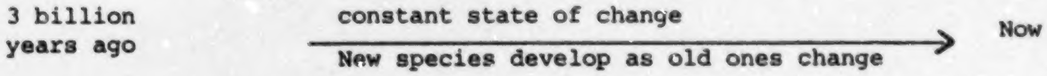
Step 5: CONCEPT MAP

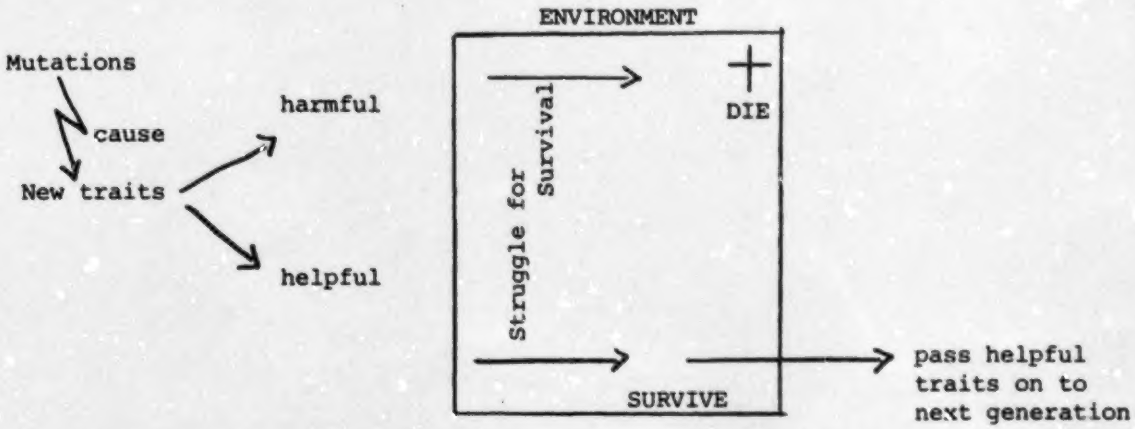

THE NATURE OF LIFE
ORIGIN OF LIFE
Geological Timetable
How much is a million?
Stack of a million dollar bills
A Challenge $10.00 for a million dots
Reading: A Million Candy Bars
Evidence for Evolution
Plant and Animal Breeding
Biochemistry
Embryology
Vestigial Organs
Homologyos Structures
Fossils
MIGRATION
ISOLATION
ENVIRONMENT
Evolution of a New Species
Convergent Evolution
Adaptive Radiation
Overpopulation
Darwin's Theory of Natural Selection
Struggle for Survival
Chromosome Mutation
Gene Mutation
DeVries
Mutation
Rate of Mutation
Variation
Recombination
Survival of the Fittest
ENVIRONMENT
Migration
Surviving organisms transmit variations to offspring

Chapter 13 Summary

Some scientists believe that life on earth began more than three billion years ago. In all the time since then, life has been in a constant state of change. New species develop as old ones change.

Biologists understand this process as evolution by natural selection. New traits appear in organisms as a result of mutations or new gene combinations. Whether these traits are helpful or harmful depends on the environment. All organisms face a constant struggle for survival. Those with the helpful traits are more likely to survive and pass these traits on. Organisms without these traits tend to die out. In the end, all members of a population may have the helpful traits.


3 billion years ago
constant state of change
New species develop as old ones change
Now


Mutations
cause
New traits
harmful
helpful
ENVIRONMENT
Struggle for Survival
DIE
SURVIVE
pass helpful traits on to next generation

This structured overview can be derived from the summary paragraph before the chapter is read by many students. For other students the teacher can show them how it is developed. This structured overview will serve as an organizational model for the chapter.

OUTLINE OF READING SELECTION

I. Our Changing Earth

  A. Earth's 5 billion years old
  B. Earth's constantly changing
  C. Change takes place too slowly to notice

II. A Story Written in Rock

  A. Sedimentary rock records earth's history
  B. Rocks can be dated from radioactive elements
  C. Gives us a calendar of earth's history

III. Life on Earth

  A. Early Earth atmosphere was composed of ammonia, methane, water vapor
  B. Energy from lightning changed gases in organic molecules
  C. When right organic molecules come together, life began

IV. Organic Variation

  A. Earth contains fossil record in sedimentary rock, amber, tar & ice

    1. countless different organisms have developed on earth

  B. A Clear pattern

    1. simple organisms present from early times
    2. complex organisms present from more recent times

  C. Evolution is change

    1. old forms decline, new forms appear

PARALLEL OUTLINE ANALYSIS

I. Our changing Earth

- A. Topic sentence (1st of Paragraph)
- B. Page 148, paragraph 2 topic sentence (2nd sentence)
- C. Page 148, paragraph 3 main idea - this paragraph is a transitional paragraph that sets the purpose for the next section with a question.

II. A Story written in Rock

- A. Page 148-4 - topic sentence (3rd sentence)
- B. Page 149-6 - maine ideas not clearly stated in a sentence
- C. Main idea of the section. Use M.C. format.

III. Life on Earth

- A. Page 149-7 - Introductory Paragraph
- B. Page 149-8 - These paragraphs provide a sequence of ideas
- C. Inferences - what complex organic compounds would have been needed to make the 1st cell?
  - what simple organic compounds would have been made 1st in order to make the complex organic compounds?
  - which gases, in the ancient atmosphere would you guess, would be recombined to produce each of the simple organic compounds listed above?

  Page 150-9 - Stanleys explanation shows Oparin's hypothesis possible.

IV. Organic Variation

- A. Page 150-10,11 - main idea of 2 paragraphs (4 ways fossil evidence is preserved)
  1. Page 150-10 - topic sentence (1st sentence)
- B. Page 150-12 - bold print topic sentence
- C. Page 150-13 - 3rd sentence - topic sentence

  bocabulary: evolution
  organic variation

  inference: if the same fossils were found in both old and new rocks, what implications would this have about evolution.

Study Guide - Learner

*literal questions
**interpretive questions

1. The topic sentence of paragraph 1 is:
   - a. the earth is more than 5 billion years old
   - b. it is hard to imagine 5 billion years
   - c. the idea of 5 billion years is so vast it seems to lose it meaning
   - d. the earth is very old

2. The topic sentence of paragraph 2 is:

   a. just as vast are the changes our planet has undergone
   b. the earth has been changing constantly
   c. land masses have risen and fallen
   d. rivers have cut deep

3. Paragraph 3 is a(n)

   a. descriptive paragraph
   b. explanatory paragraph
   c. summarizing and concluding paragraph
   d. transitional paragraph

4. What is the topic sentence of paragraph 4?

   a. the rings of a tree can tell us alot about its life.
   b. sedimentary rock records millions of years of the earth's history.
   c. great pressure turned lower layers to rock.
   d. layer after layer, new rock was formed on top of old.

5. The main idea of paragraph 6 is:

   a. uranium is found in rock layer
   b. rocks can be dated from radioactive elements
   c. uranium changes to lead in 4.5 billion years
   d. elements decay and change to other elements at a steady rate

6. Paragraph 7 is a(n)

   a. introductory paragraph
   b. descriptive paragraph
   c. transitional paragraph
   d. explanatory paragraph

7. Paragraph 8 tells you that

   *a. the early earth atmosphere was composed of ________________________
   **b. if you were to land on a planet with an atmosphere like this, would you be able to leave your space ship without a space suit? Why?
   **c. these molecules in the atmosphere reacted, and changed into __________ using energy from ____________.
   **d. Which atmosphere molecules, would you guess, might have reacted to produce simple sugars?

   ________ + ________ $\longrightarrow C_6H_{12}O_6$

   amino acids?

   __________ + ____________ $\longrightarrow NC_2H_4O_2\text{-}R$

   fatty acids?

________ + ________ → $C_3H_5O_3\ -(O-C-(CH_2)_n-CH_3)_x$

Nucleotides?

________ + ________ → $N\ C\ H\ O-C_5H_8O_5\ -H_2PO_4$

**e. What simple organic compounds would have combined to form proteins?

_________ + _________ → proteins

carbohydrates?

_________ + _________ → carbohydrates

fats?

_________ + _________ → fats

nucleic acids?

_________ + _________ → nucleic acids

*f. life began when the ____________ organic molecules came together in the __________ way.

8. Read paragraphs 10 & 11 (p. 150). The main idea of these two paragraphs is:

   a. countless organisms have developed on earth
   b. organisms are preserved in the earth in many different ways
   c. sedimentary rock contains fossils
   d. the earth contains fossil record in sedimentary rock, amber, tar pits, and ice.

*9. What information do we have that supports the main idea

   a. when animal get stuck in amber, or tar, they get stuck, die, and are preserved.
   b. countless different organisms have developed on earth.
   c. the fossil record in sedimentary rock, amber, tar pit and ice.
   d. sedimentary rock contains fossils

*10. (Simple, Complex) organisms have been present on earth for the longest time. (Simple, Complex) organisms have been present on earth over a shorter period of time.

*11. The process of change in which old forms of organisms decline eventually disappear from earth, while new forms of organisms appear is called ______.

*12. Different kinds of organisms are different from each other. Also, there are differences among the individuals of a kind of organism. These differences are called _________________.

*13. If the same fossils were found in both old and new rock, what implications would this have about evolution?

a. change has taken place only during more recent times.
b. change, and evolution, have not taken place.
c. this would be positive evidence that evolution has occurred.

Study Guide - Intermediate

1. The main idea of paragraph 1 is:

a. its hard to imagine how old the earth is
b. the idea of a billion years has no meaning
c. the earth is very old
d. the earth is changing

2. What is the main idea of paragraph 2?

3. What kind of paragraph is paragraph 3?

4. What is the main idea of paragraph 4?

a. the earth's history can be learned from the layers of sedimentary rock
b. sedimentary rock is formed from particles that settle to the bottom of bodies of water and are pressed into rock
c. new rock is formed over old rock
d. tree rings the age of a tree and its history

5. The main idea of paragraph 6 is:

a. uranium is found in rock layers
b. rocks can be dated from radioactive elements
c. uranium changes to lead in 4.5 billion years
d. elements decay and change to other elements at a steady rate.

6. Paragraph 7 is a(n)

a. introductory paragraph
b. descriptive paragraph
c. transition paragraph
d. explanatory paragraph

7. *A. Three sentences in paragraph 8 describe the sequence of events that led to the development of the first living cell. In your own words, list this sequence of events.

**B. If you were to land on a planet with an atmosphere like the ancient earth, would you be able to leave your space ship without a space suit? Why?

**C. The molecules in the ancient atmosphere reacted and changed into______ using energy from ___________.

**D. Which atmospheric molecules, would you guess, might have reacted to produce simple sugars? ____________ amino acids? __________________ fatty acids? _________________ nucleotides? ________________ (Need help? See Chapter 3)

**E. What simple organic compounds would have combined to form proteins? _____________ carbohydrates? ______________ fats? ________________ nucleis acids? _____________________ (Need help? See Chapter 3)

*8. Read paragraphs 10 & 11 (page 150). What is the main idea of these two paragraphs?

*9. Summarize what evidence supports this main idea.

*10. State the main idea of paragraph 12 in your own words.

*11. From paragraph 13 define evolution including the ideas of change, old forms and new forms.

*12. From paragraph 13 define organic variation

**13. If the same fossils were found in both old and new rock, what implications would this have about evolution?

Study Guide - Advanced

1. What is the main idea of paragraph 1?

2. What is the main idea of paragraph 2?

3. After reading paragraph 3, what will be the main idea of the next section "A Story Written in Rock?"

4. What is the main idea of paragraph 4?

5. What's the main idea of paragraph 6?

6. Paragraph 4, 5, 6 can best be summarized by

   a. sedimentary rock contains information that provides us with a calendar of the earth's history
   b. scientists use sedimentary rock to determine eras and periods by radioactive dating
   c. the sedimentary rock formed over many eras and periods contains lead that has come from uranium
   d. rings of trees that are buried in sedimentary rock hold a record of the earth history

7. Paragraph 7 is what kind of paragraph?

8. *A. From paragraph 8, in your own words, list the sequence of events that led to the development of the first living cell.
   **B. If you were to land on a planet with an atmosphere like the ancient earth, would you be able to leave your space ship without a space suit? Why?
   **C. The molecules in the air of the ancient earth reacted and changed to

_________________ using energy from ___________?

**D. Which atmospheric molecules, would you guess, might have reacted to produce simple sugars? _____________ amino acids? _________________ fatty acids? ______________ nucleotides? _________________

E. What simple organic compounds would have combined to form proteins? _____________ carbohydrates? _____________ fats? __________________ nucleic acids? ________________

9. Read paragraphs 10 & 11 (page 150). What is the main idea of these two paragraphs?

10. Summarize what evidence supports this main idea.

*11. State the main idea of paragraph 12 in your own words.

*12. From paragraph 13, define evolution.

*13. From paragraph 13, define organic variation

**14. If the same fossils were found in both old and new rock, what implications would this have about evolution?

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Project CAPABLE

CLASSROOM ACTION PROGRAM

AIM: BASIC LEARNING EFFICIENCY

"to make each student a more capable learner"

CO-DIRECTORS

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Math

APRIL - MAY REPORT

INTEREST, MOTIVATION, ASSESSMENT

TITLE IV: PART C
DEVELOPMENTAL GRANT

Paul Germann

Science

Evaluation Plan

The following outline has been adapted from several sources to facilitate planning:

1. Needs	-Why is this program necessary?
2. Program objectives	-What are objectives of the program that will meet these needs?
3. Program Assumptions	-What ideas do we assume are true in the conception of Needs, Objectives, & Program
4. Hypothesis & Deductions	-What outcomes do we expect when the program is implemented?
5. Information Requirement	-What information is needed to determine if hypothesis and objectives have been met?
6. Information Source	-From Whom can the necessary information be secured?
7. Instruments	-What can be used to obtain the information?
8. Design	-Who will complete the instruments and what comparisons will be made?
9. Time schedule	-When will the information be collected, analyzed and reported?
10. Analysis	-What do we do with the data?
11. Report	-Who will receive the report? How will the data from the reports be used?

Need

In the conception of Project Capable we identified a need. We saw that many students were having difficulty learning because they lacked certain skills that are necessary for effective learning. At a workshop we asked our faculty, "When you are frustrated because a student cannot learn, what is it that you complain about? Specifically, what is it that the student cannot do that interferes with his learning?" The result was a list of learning skills:

- Reading
- Speaking
- Writing
- Listening
- Directions
- Vocabulary
- Decision Making
- Opinion
- Perceptions
- Comprehension
- Study Skills
- Use of Sources
- Notetaking
- Computational
- Basic Content Knowledge
- Physical Skills
- Affective Domain
- Motivation
- Self concept
- Self discipline
- Positive values
- Social skills
- cultural values
- Imagination

Statement of Need: As a result of activities during a workshop and a needs assessment survey, the staff of Madawaska High School has identified a need to implement a Classroom Action Program that will increase the students proficiency in the basic learning skills required by students to become more capable learners in subject area content.

Objective

Our need suggest that we all expect student growth in two areas as a result of the project: (1) basic learning skills and subject area content. Pretesting and post-testing will measure the amount of student growth that has taken place. To determine if that growth is due to the project, the results will have to be compared with comparison groups who did not participate. These groups are not made by random assignment, therefore they are called "comparison" groups, not "control" groups.

Statement of Objective: As a result of Project Capable, 80% of the participating high school students (grades 9-12) will show, from pretesting in September, 1981 and Post-testing in June, 1982, a significant gain in command of basic learning skills and a significant increase in their achievement in subject area content as compared to comparison groups.

Assumptions

There are several underlying assumptions to this project. We assume that:

(1) a certain set of basic learning skills are necessary to learn effectively.

(2) we can identify these skills.

(3) exercises can be written which will foster the learning of the skills.

(4) those students who possess basic learning skills will learn more effectively than those who do not.

(5) through appropriate measurement devices it is possible to determine (a) how well students have mastered basic learning skills, and (b) the effect of this increased skill level on the learning of subject area content.

Hypothesis and Deductions

Statement of Hypothesis: (a) A specially designed format, lessons, and exercises will increase student proficiency in basic learning skills and (b) an increase in student proficiency in basic learning skills will result in better learning of subject area content.

Statement of Deductions: If it is true that specially designed format, lessons, and exercises will increase student proficiency in basic learning skills, and this will result in better learning of subject area content, then, by providing such a Classroom Action Program we should be able to measure significant improvement in (a) basic learning skills, and (b) understanding and retention of subject area content, as compared to a pretest and to comparison groups.

Information Requirements

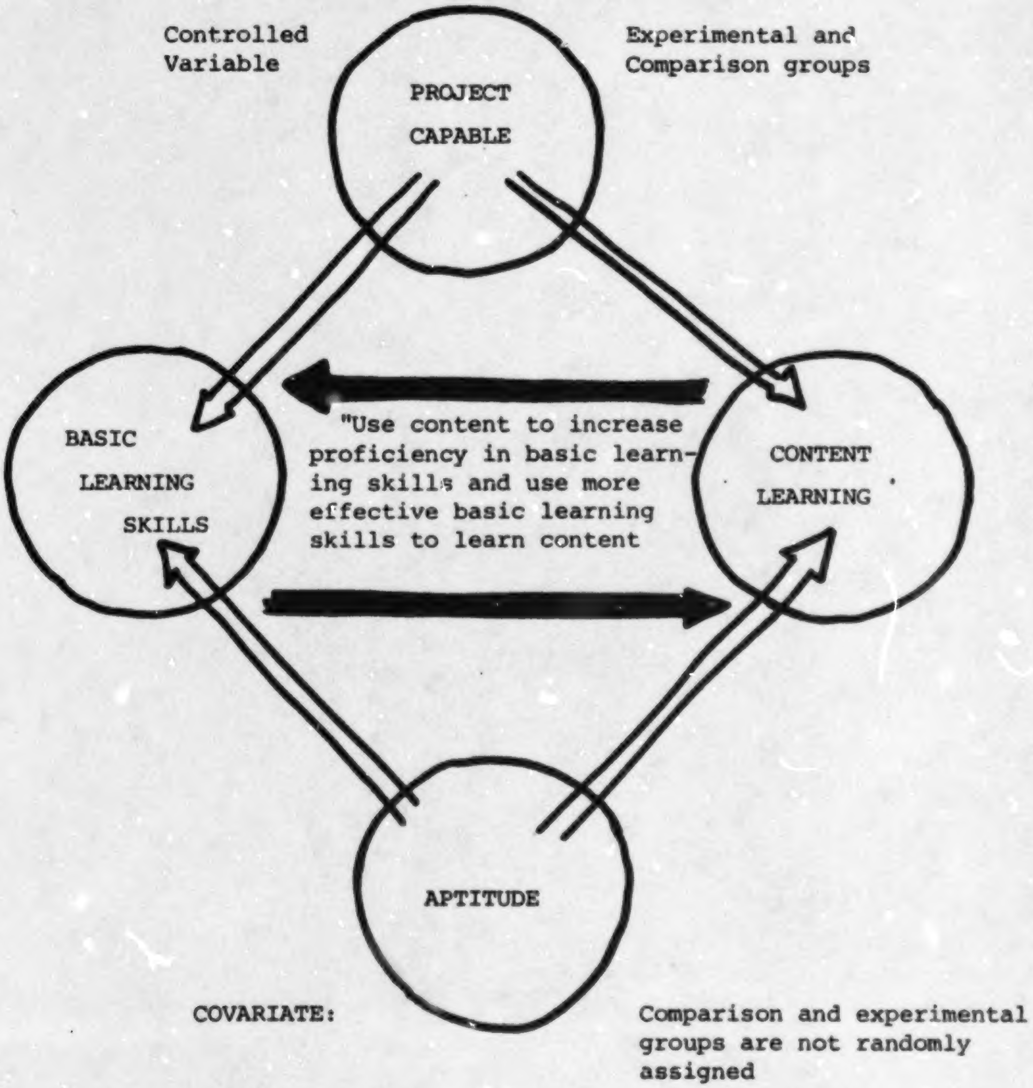
In order to evaluate the success of our objective we will need:

-scores from norm-based tests on basic learning skills and subject area content administered to experimental and comparison groups at the beginning and end of the school year.

-scores from teacher constructed tests on basic learning.

-notes from teacher log maintained during pre-experimental and experimental school year.

-scores which reflect the students aptitude. These are needed because aptitude will be a second variable that is not controlled, since classes cannot be randomly assigned. This variable will have to be controlled statistically through analysis of covariance.


Controlled Variable
PROJECT CAPABLE
Experimental and Comparison groups
BASIC LEARNING SKILLS
"Use content to increase proficiency in basic learning skills and use more effective basic learning skills to learn content
CONTENT LEARNING
APTITUDE
COVARIATE:
Comparison and experimental groups are not randomly assigned

Information Source

The high school (grades 9+10) biology students.

Instruments

Formal

DAT - Differential Aptitude Test
SRA - Science Research Associates Level H (Iowa Test Educational Development)
SDRT - Stanford Diagnostic Reading Test

Watson - Glaser Critical Thinking Appraisals

Informal

- Tests
- Inventories
- Teacher Log
    - Observation scales
    - case studies

Considerations in selecting instruments:

1. Cost
2. Timing
3. Credibility of Findings (audience)
4. Degree of obtrusiveness
5. Amount of coordination needed
6. Efficiency

Design

We wish to determine if students have better basic learning skills and learn better when they are exposed to the project than when they are not. This will require two experimental groups, a treatment group which receives the project and a comparison group which does not. Both groups will get a pretest to determine what they know when they enter the experimental period and a posttest to find out how much they have improved. The degree of improvement can be compared to see if the program is successful. Since, in our case, the experimental groups will not be formed by random assignment, this design may be called a "Non-randomized Control-group Pretest-Posttest Design" (Van Dalen).

	Pretest	Treatment	Posttest
Treatment group	T_{1E}	X	T_{2E}
Comparison group	T_{1C}		T_{2C}

DE = mean of differences between experimental treatment
groups pretest and posttest scores
DE = $T_{2E} - T_{1E}$

Dc = mean of differences between comparison group's
pretest and posttest scores
Dc = $T_{2C} - T_{1C}$
Compare DE & DC to ascertain effect of X

There are other kinds of comparison groups that can be used besides, or in additon to, those that are run simultaneous with the treatment group. If we have normalized tests, we can use norm groups for comparison. Post performance of similar groups might be used. If the pre & post-tests can be given the year to treatment to the same students a time series design can be used using the students' previous years results for comparison.

INSTRUMENTS	A	S	O	N	D	J	F	M	A	M	J	A	S	O	N	D	J	F	M	A	M	J	A	S	O	N	D	J	F	M	A	M	J
SUMMATIVE																																	
FORMAL																																	
DAT		Given in 8th & 10th grades																															
SRA			■											■											■								
SDRT		X									O		X									O		X									O
W-G CTA	X									O		X									O		X									O	
INFORMAL																																	
COMP. BLS TEST	X									O		X									O			X								O	
COMP. BIOLOGY TEST	X										O	X										O		X									O
FORMATIVE																																	
SKILL TESTS & INVENTORIES		End of ea. unit												End of ea. unit												End of ea. unit							
BIOLOGY																																	
TEACHER LOG				Daily												Daily												Daily					
				1980-81											1981-82										1982-83								
		PRE-EXPERIMENTAL												EXPERIMENTAL										POST-EXPERIMENTAL									

Time Schedule

KEY:

■ = given once a year

X = Pretest

O = Posttest

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Analysis

In Project Capable, we wish to determine the relationship between our Classroom Action Program and student achievement in basic learning skills and in content. We hope to find that the Classroom Action Program will significantly improve student achievement. In order to determine if achievement is improved by the project, we will study and compare two groups, one which gets the program and one which does not.

The two groups that will be compared should be made up by randomly assigning students to each group. If this is done successfully, both groups should be identical, except for the factor we want to test, in this case, the Classroom Action Program. This is the independent variable, and, in this case, it is qualitative or categorical (that is, two categories or groups: treatment groups and comparison group).

The achievement scores obtained when the treatment application is finished are the dependent variable. These scores depend upon the independent variable. Any different in the achievement scores of the two groups can be due to the difference in treatment, scince that is the only difference between the two randomly assigned groups.

We will be unable to make random assignments to the treatment and comparison groups. As a result, we expect the two groups to be different in ways other than treatment. Some of these differences may also have an effect upon the dependent variable, the achievement scores. The most obvious such differance, is in ability. If the two groups are not the same in ability, then this may account for differences in achievement, instead of the project. This is a nuisance variable.

Another nuisance variable that may affect the dependent variable is that some students may prior knowledge of the basic learning skills because they have participate in a project treatment class at some prior time. Still another may be that some students are enrolled in two project classes while others are not.

Wildt & Ahtoda suggest that analysis of covariance can be used to:

1. increase the precision of randomized experiments. Analysis of covariance can statistically control nuisance variables.

2. statistically remove pre-existing differences among groups when the groups are not randomly assigned.

3. remove differences in the dependent variable due to differences in extraneous variables.

4. regression analysis to control for categorical variables when examining the relationship between two or more quantitative variables.

Both (2) and (3) are applicable to this project.

Analysis of covariance is considered appropriate under the following conditions:

1. There are one or more extraneous sources of variation believed to affect the dependent variable.

2. This extraneous source of variation can be measured on an interval (ratio) scale.

3. The functional form of the relationship between the dependent variable and the extraneous variables is known (a linear relationship is usually assumed).

4. Direct experimental control of extraneous sources of variation is either not possible or not feasable.

5. It is possible to obtain a measure of the extraneous variation that does not include the effects of the treatment.

    a. The observations on the covariant are obtained prior to treatment.

    b. The observations on the covariant is unaffected by the treatment.

Project Capable satisfies all of these conditions. There are several extraneous sources of variation that may affect the dependent variable. The two groups, treatment and comparison will probably differ in ability, prior knowledge, and enrollment in other concurrent project courses. Ability can be measured on an aptitude test and prior knowledge on a pretest. Both of these will provide data on an interval scale. The relationship between these extraneous variables and the dependent variable can be assumed to be linear. Direct control of these extraneous factors by random assignment is not possible. This would put an impossible burden on an already difficult scheduling problem. It will be possible to measure the extraneous variables prior to treatment, thereby avoiding any effect of treatment on the extraneous variables.

Analysis of covariance, the, is useful in studies that are experimental (randomly assigned, well controlled experimental groups), quasi-experimental (random assignment is not possible and naturally occurring groups are used) or observational (data is gathered as it naturally occurs in an uncontrolled enironment). These studies are characterized by the presence of a quantitative dependent variable and both quantitative and qualitative independent variables.

In Project Capable we are concerned with relationship between the project and an increase in understanding of basic learning skills and content. We have a qualitative independent variable. This is our two groups, the experimental group which will get the treatment, and the comparison group which will not get the treatment. Our quantitative dependent variable are the scores on content and basic learning skills tests. We have a quantitative independent variable, or covariante in the ability of the students as measured by an aptitude test. This is nuisance variable. We would control for it if we could. It is assumed that this covariante influences the dependent variable, but the relationship is not of primary concern. Another covariante that may influence the dependent variable but is not of primary interest is previous knowledge, especially in the basic learning skills. This may be a factor when some students have been previously (or are concurrently) enrolled in another Project Capable program. This covariante can be measured by scores on a pretest.

These covariantes (ability & previous knowledge) are included in the analysis to remove extraneous variation from the dependent variable. This analysis procedure will adjust the dependent variable (basic learning skills and content scores) for differences in the covariantes (ability & previous knowledge) and then invetigate the relationship between the qualitative independent variable (treatment group/comparison group) and the adjusted values of the dependent variable (basic learning skills and content scores).

The relationship between the experimental groups and the dependent variable might be expressed as follows:

$$y_{\text{Treatment}} = \tau_{\text{treatment}}$$

$$y_{\text{comparison}} = \tau_{\text{comparison}}$$

We expect $y_{\text{treatment}}$ to be greater than $y_{\text{comparison}}$ as a result of treatment ($\tau_{\text{treatment}}$) rather than no treatment ($\tau_{\text{comparison}}$)

The relationship between covariantes, which are independent quantitative variables, and the dependent variable is assumed to be linear. A linear relationship can be expressed by .

$$y = b\,x + c$$

where b is the slope, c is the y intercept, y is the dependent variable, and x is the independent quantitative variable.

The covariance model would show that the observed value of the dependent variable is a result of the effect experimental treatment plus the effect of the covariante (nuisance variables) plus the effect of other factors that have not been accounted for. We can write this as follows:

Observed value of the dependent variable = constant + effect due to treatment group + effect of the covariante + residual effect.

or

$$Yij = u + \tau i + B(Xij - \bar{X}) + eij$$

where

yij	is the jth observation in the ith group
u	is a constant that represents the overall mean without effects variables
τi	is effect due to treatment or non-treatment (a categorical dependent variable)
$B(Xij-\bar{X})$	is the effect of the covariante (a quantitative independent variable)
eij	is the effect of any other factors that have an effect on the dependent variable.
B	is the regression coefficient represents the avery effect of a one unit change in the covariante on the dependent variable (or, the slope when the covariante is graphed against the dependent variable)
X_{ij}	is the jth observation in ith group for the covariante
$\bar{X}$	is the mean value of the covariante

We can obtain an adjusted dependent variable by subtracting out the influence of the covariante.

$$Yij(adj) = Yij - B(Xij-\bar{X}) = u + \tau i + eij$$

The adjusted Y values from analysis of covariance can be used in other statistical analysis, such as:

1. An F value, which will tell us if the difference between the treatment and comparison groups is significant (X = .05 or .01) or possibly due to chance.

2. geometric representation, which show regression lines obtained from graphing the dependent variable against the covariante.

3. comparison of means
4. frequency distribution
5. adjusted group means $\bar{y}_1 (adj) = \bar{y}_1 - \beta (\bar{x}_1 - x)$
6. t-value

Computation of analysis of covariance is complicated and is best done by the computer.

To use analysis of covariance in a valid manner, the following assumptions are made:

1. The scores on the dependent variable are a linear combination of four independent components:
    a. an overall mean
    b. a treatment effect
    c. a linear covariante effect
    d. an error term
2. The error is normally & independently distributed with zero mean and variance (there are both positive and negative errors)
3. The (weighted) sum overall groups of the treatment/group effect is zero
4. The coefficient of the covariante, B (the slope of the regression line) is the same for each treatment/group.
5. The covariante and a fixed mathematical variable are measured without error, not a stockastic variable.

The result of analysis of covariance will be an F ratio. We will use the F-test to determine if the difference between the two treatment groups is significant, or possibly due to chance. We will make the null hypothesis that there is no significant difference between the experimental and comparison groups, and we hope to reject it. The equation for an F-ratio is:

$$F = \frac{\text{between -groups mean squares}}{\text{within-groups mean squares}} = \frac{\frac{\text{between-groups sum of squares}}{K-1}}{\frac{\text{within-groups sum of squares}}{N-K-1}}$$

These sum of squares must be adjusted for the convariante and the grand mean. If Y is the value of the dependent variable and X is the value of the covariante, then:

$$F = \frac{\frac{Byy(adj)}{K-1}}{\frac{Eyy(adj)}{N-K-1}}$$

k = number of groups

n = number of scores

where Byy(adj) = adjusted between-groups sum of squares

Eyy(adj) = adjusted within-groups sum of squares

Byy(adj) is calculated as follows:

$$Byy(adj) = Tyy(adj) - Eyy(adj)$$

where Tyy(adj) = adjusted total sum of squares of y

Eyy(adj) = adjusted with-group sum of squares of y

Tyy(adj) is calculated as follows:

$$Tyy(adj) = Tyy - \frac{Txy^2}{Txx}$$

where Tyy = total sum of squares of y

Txy = total sum of squares for the cross product of x & y

Txx = total sum of squares of x

$$Eyy(adj) = Eyy - \frac{Exy^2}{Exx}$$

where Eyy = within group sum of squares of y

Exy = within group sum of squares for the cross product of x & y

Exx = within group sum of squares of x

$$Tyy = \sum_{i=1}^{K} \sum_{j=1}^{n} (yij-\bar{y})^2$$

$$\mathrm{Txy} = \sum_{i=1}^{k} \sum_{j=1}^{n} (xij - \bar{X})\ (yij - \bar{y})$$

$$\mathrm{Txx} = \sum_{i=1}^{k} \sum_{j=1}^{n} (xij - \bar{x})^{2}$$

$$\mathrm{Eyy} = \sum_{i=1}^{k} \sum_{j=1}^{n} (Yij - \bar{Y}i)^{2}$$

$$\mathrm{Exy} = \sum_{i=1}^{k} \sum_{j=1}^{n} (Xij - \bar{X}i)\ (Yij - \bar{Y}i)$$

$$\mathrm{Exx} = \sum_{i=1}^{K} \sum_{j=1}^{n} (Xij - \bar{X}i)^{2}$$

Report

A project report needs to be prepared. In considering such a report, several questions must be addressed:

1. Who will be the audience?

   There may be several audiences and their interests in in the project may be quite varied. Several reports may be necessary, each one addressed to its particular audience. The audiences may include: students, parents, instructional staff, administrative staff, superintendent, school board, community advisory councils, and state and federal agencies.

2. What is the purpose of the report?

3. What do they need to know for this purpose?

4. What kind of presentation will best convey the information the audience needs to know in a way that is meaningful and understandable to them?

5. When is the report due?

6. Are there any interim reports?

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***All members used same resources.**